

SECTION B



**TITLE: - 2 X 660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION :

REV.NO. 00

SHEET

KHARGONE SUPER THERMAL POWER PROJECT

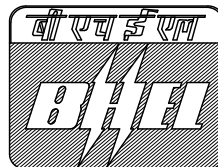
2 X 660 MW

**TECHNICAL SPECIFICATIONS
(INTAKE WATER PUMP HOUSE COMPLEX)**

CIVIL , STRUCTURAL & ARCHITECTURAL WORKS

FOR INTAKE WATER PUMP HOUSE COMPLEX

PE-TS-K13-600-C001



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, PPEI BUILDING

SECTOR 16A, NOIDA-201301



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PREAMBLE

This specification is intended for finalization of Pre bid tie up between PEM & Bidder.

Standard technical details as indicated in specification shall be agreed upon between BHEL & Bidder.

Technical requirements are stipulated in this Volume which comprises of

- Section A : This section outlines the scope of work
- Section B : This section provides 'Project Information' not covered
in 'Project Synopsis' , if any
- Section C : This section indicates the technical requirements
specific to the contract not covered in Section D
- Section D : This section comprises of technical specification(s)
-
- Annexures I : Hydrographic survey for intake Pump house
- Annexures II : Layout of Intake pump house
- Annexures III : Layout of switchgear building complex
- Annexures IV : GA of Transformers
- Annexures V : Contour survey and Terminal points

The requirements mentioned in the Section C shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the Section D in the specification.



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SECTION B

PROJECT INFORMATION



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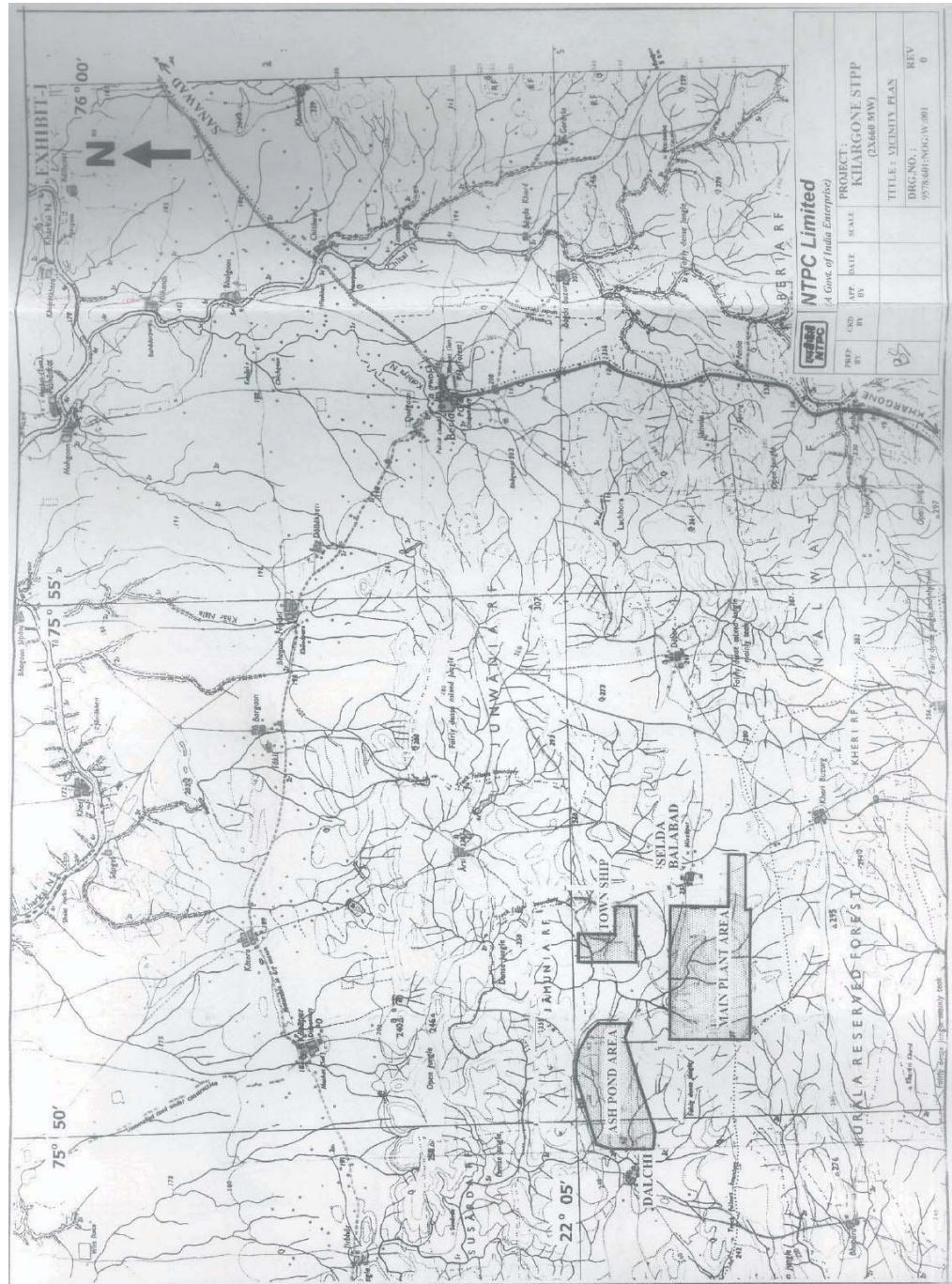
OWNER	NTPC LIMITED
NAME OF PROJECT	KHARGONE SUPER THERMAL POWER PROJECT (2 X 660MW)
SITE LOCATION	Location of site is on the bank of Omkareshwar dam on river Narmada, as shown in attached drawings in Annexures. The site is approximately 2.82Km away from Gunjari village, which is connected to state highway through single road.
NEAREST RAILWAY STATION	Nearest Railway Station is Sanawad on Indore – Khandwa Meter Gauge section.
NEAREST AIRPORT	The nearest commercial airports Indore & Bhopal are located about 105 Kms. & 290 Kms from site respectively.

CLAUSE NO.	PROJECT INFORMATION			एन टी पी सी NTPC
1.00.00	BACKGROUND The present proposal is to have new green field power project by installing two unit of 660 MW in the Khargone Distt. of Madhya Pradesh.			
1.01.00	Location and Approach The site is located near Selda village & Sanawad town in Barwah tehsil at a distance of about 105 Kms from Indore and about 30 Kms from Sanawad town in Madhya Pradesh. The site is approachable from Sanawad on Indore – Khandwa State Highway through PWD road. The road distances of proposed site from major cities/towns are as follows: Indore City : 105 Kms. Bhopal City : 290 Kms. Rail Link Nearest Railway Station is Sanawad on Indore – Khandwa Meter Gauge section. Airport The nearest commercial airports Indore & Bhopal are located about 105 Kms. & 290 Kms from site respectively. Vicinity Plan of the project is placed at Annexure-I			
1.02.00	Land About 1334 Acres of land has been identified. The land is mainly barren Govt. land with some single crop private land. Most of the land is under NTPC possession and free from encroachment.			
1.03.00	Water Make up water requirement for the project shall be about 40 Cusecs. Narmada River is passing at approx 15 Kms (North) from proposed site. Two dams of Narmada Hydro Development Corporation (NHDC) on river Narmada {Maheshwar Dam (North - West) & Omkareshwar Dam (North East)} are located at distances of about 15 Kms and 45 Kms respectively. Water is proposed to be drawn from Omkareshwar Dam, located at a distance of about 45 Kms. from site.			
1.04.00	Fuel (Coal)			
1.04.01	Coal Availability Coal requirement for 1320 MW capacity project is estimated as 6.51 million tonne/annum, considering average GCV of 3500 kcal/kg & unit heat rate as 2317.44 Kcal/kWh.at 90 % PLF.			
KHARGONE STPP (2 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC. NO.:CS-9578-001(R)-2	SUB-SECTION-I B PROJECT INFORMATION	PAGE 3 OF 13

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1.04.02	Coal Transportation Coal is proposed to be transported from coalfields to site (located about 890 Kms) through Indian Railway System. Sanawad Rly station on Indore- Khandwa MG line has been identified as railway siding for coal/ equipment transportation. Indore- Khandwa MG line is under conversion to BG line by Indian Railways.		
1.05.00	Meteorological Data Important meteorological data at Khargone is placed at Annexure-II.		
1.06.00	Plant Water Scheme The Plant water scheme is described below.		
1.06.01	Condenser Cooling (CW) Water System It is proposed to adopt re-circulating type CW system with cooling towers for the project.		
1.06.02	Equipment Cooling Water (ECW) System (Unit Auxiliaries) All plant auxiliaries shall be cooled by De-mineralized water (DM) in a closed circuit. The primary circuit DM water shall be cooled through heat exchangers by Circulating Water tapped from CW system in a closed secondary circuit. The hot secondary circuit cooling water shall be cooled in the cooling towers and shall be returned back to the system.		
1.06.03	Ash Water System (a) It is proposed to operate ash water system in a closed circuit. The ash water from the ash dyke shall be re-circulated. During re-circulation mode, the make up to the ash water system (to compensate for the ash water blow down and evaporation loss in ash dyke) shall be supplied from CW blow down. (b) During initial stage when decanted ash water is not available, the ash water system shall be operated in once through mode and make up water to ash water system shall be given from CW blow down as well as raw water system. (c) Considering total ash handling plant water requirement of 2600 Cu.M/hr. (excluding the water required for cooling of air compressors and vacuum pumps but inclusive of seal water of ash slurry pumps during re-circulation mode operation, it is expected that about 700 M³/hr of decanted ash water shall return to the ash handling system after accounting for evaporation loss.		
1.06.04	Other Miscellaneous Water Systems (a) CW system blow down water shall be used for meeting the Fly ash and bottom ash system requirement etc.		
KHARGONE STPP (2 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC. NO.:CS-9578-001(R)-2	SUB-SECTION-I B PROJECT INFORMATION PAGE 4 OF 13

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1.07.00	(b) The service water shall be taken from clarified water tank of Pretreatment plant. Service water (wash water) collected from various areas shall be treated using oil water separators, tube settlers, coal settling pits etc. as per requirement and treated water from liquid effluent treatment plant shall be recycled back to the service water system for re-use.		
	(b) The drinking water requirement of the plant shall be provided from water treatment plant.		
	(c) Steam Cycle make-up water, makeup to the primary circuit of ECW (unit auxiliaries) system, boiler fill water and makeup to the hydrogen generation plant shall be provided from demineralising plant.		
	(d) The quality of raw water is enclosed with this sub-section as Annexure-III .		
1.07.00	Criteria for Earthquake Resistant Design of Structures and Equipment All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed for seismic forces as given in the Part - B of this section.		
1.08.00	Criteria for Wind Resistant Design of Structures and Equipment All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given as given in Part B of this section.		
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VICINITY PLAN



CLIMATOLOGICAL TABLE

Rainfall data by Indian Meteorological Department (IMD) for Khargone (near Selda village & Sanawad town in Barwah tehsil) is attached (from 1969 to 1980). For additional data, Bidder has to arrange for necessary input directly from IMD under intimation to the owner.

[illegible]

RAW WATER ANALYSIS REPORT

CERTIFICATE ISSUED TO
NHDC LIMITED
OMKARESHWAR POWER STATION, URJA VIHAR,
SIDHMARKUT, D-KHANDWA, M.P.

CHOKSI LABORATORIES LIMITED
(CORPORATE OFFICE & CENTRAL LABORATORY)
6/3, Manoramagan, Indore - 452 001, INDIA.
Tel. : (0731) 4243068 (30 Lines), Fax : (0731) 2480593
E-mail : indore@choksilab.com, Website : www.choksilab.com

CERTIFICATE OF ANALYSIS

PARTICULARS OF SAMPLE SUBMITTED

Nature :	WATER	Your reference No. :	N0622
Batch No. :	NARMANA WATER	Date of Receipt :	20/05/2010
Date of Mfg. :	NM	Our Reference No. :	04353/10-11
Quantity :	02 LTR	Page No. :	1 of 1
Packing :	PLASTIC BOTTLE	Date :	24/05/2010
Sealed/Unsealed :	UNSEALED		

AS PER IS: 10500-1991

SN. TEST NAME	RESULTS	SPECIFICATION
1. Colour, Hazen Units	<1	Max. 5
2. Odour	Unobjectionable	Unobjectionable
3. Taste	Not performed*	Agreeable
4. Turbidity, NTU	0.9	Max. 5
5. Total Dissolved Solids, mg/l	146.00	Max. 500
6. pH Value	8.11	6.5 to 8.5
7. Hardness, as CaCO ₃ , mg/l	108.90	Max. 300
8. Calcium, as Ca, mg/l	37.71	Max. 75
9. Chloride, as Cl, mg/l	10.61	Max. 250
10. Sulphate, as SO ₄ , mg/l	16.82	Max. 200
11. Nitrate, as NO ₃ , mg/l	1.58	Max. 45
12. Fluoride, as F, mg/l	<0.2	Max. 1.0
13. Phenolic Compounds, as C ₆ H ₅ OH, - mg/l	Not detected	Max. 0.001
14. MPN Index for Coliform Bacteria - per 100ml	13	Max. 10
15. Residual free Chlorine, mg/l	Not detected	Max. 0.2
16. Alkalinity, as CaCO ₃ , mg/l	104.00	Max. 200
17. Magnesium, as Mg, mg/l	7.21	Max. 50

Note: 1. Date of Completion of Analysis: 24/05/2010
2. Chemical Method of Analysis as per IS: 3025.
3. Microbiological Method of Analysis as per IS: 1622-1981.
4. *Due to failure in MPN.

For CHOKSI LABORATORIES LTD.,
Authorized Signatory.

For Choksi Laboratories Ltd.
Authorized Signatory
Kavishwasa (IDA-0012)
Deputy - Agro Analysis
Authorized Signatory

Note: 1. This report can neither be used as an evidence in the Court of Law, nor can it be used in part or full in any media without prior permission.
2. The result listed refer only to the tested samples and applicable parameters.
3. Perishable samples will be destroyed after testing; pesticide samples will be returned with the report.
4. Sample (s) not drawn by us, unless otherwise mentioned.

GEN-0614070

CLAUSE NO.	PROJECT INFORMATION			एनटीपीसी NTPC																								
	ANNEXURE-IV-1 TABLE-1 LIGHT DIESEL OIL CHARACTERISTICS AS PER IS 15770-2008 <table><tr><td>Characteristics</td><td>LDO</td></tr><tr><td>1. Pour Point (max)</td><td>21 °C & 12°C for Summer and Winter respectively</td></tr><tr><td>2. Kinematic viscosity in centistokes at 40 deg.C</td><td>2.5 to 15.0</td></tr><tr><td>3. Sediment percent by mass (max)</td><td>0.10</td></tr><tr><td>4. Total sulphur percent by mass (max)</td><td>1.5</td></tr><tr><td>5. Ash percentage by mass (max)</td><td>0.02</td></tr><tr><td>6. Carbon residue (Rams bottom) percent by pass (max.)</td><td>1.50</td></tr><tr><td>7. Acidity inorganic</td><td>Nil</td></tr><tr><td>8. Flash point (Min.) - Pensky Martens</td><td>66 deg.C</td></tr><tr><td>9. Copper strip corrosion for 3 hours at 100°C</td><td>Not worse than No. 2</td></tr><tr><td>10. Water content, % by volume (max)</td><td>0.25</td></tr><tr><td>11. GCV(kcal/kg)</td><td>10,000</td></tr></table>				Characteristics	LDO	1. Pour Point (max)	21 °C & 12°C for Summer and Winter respectively	2. Kinematic viscosity in centistokes at 40 deg.C	2.5 to 15.0	3. Sediment percent by mass (max)	0.10	4. Total sulphur percent by mass (max)	1.5	5. Ash percentage by mass (max)	0.02	6. Carbon residue (Rams bottom) percent by pass (max.)	1.50	7. Acidity inorganic	Nil	8. Flash point (Min.) - Pensky Martens	66 deg.C	9. Copper strip corrosion for 3 hours at 100°C	Not worse than No. 2	10. Water content, % by volume (max)	0.25	11. GCV(kcal/kg)	10,000
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CLAUSE NO.	PROJECT INFORMATION						
	ANNEXURE-IV-2						
	TABLE-1 – A						
	DOMESTIC COAL CHARACTERISTICS						
S No.	Characteristics (As received basis)	Range of 95% coal supplies			Range of 5% coal supplies		
		Column-1	Column-2	Column-3	Range of Adequacy coal		
1.0	PROXIMATE ANALYSIS	Design	Worst	Best	Worst	Best	
1.1	Total Moisture (%)	13	15	11	15	10	
1.2	Ash (%)	42	46	35	47	33	
1.3	Volatile matter (%)	22	20	24	20	24	
1.4	Fixed carbon (%)	23	19	30	18	33	
2.0	ULTIMATE ANALYSIS						
2.1	Carbon (%)	31.8	28.4	40.17	27.58	42.38	
2.2	Hydrogen (%)	3.1	2.3	3.2	2.2	3.3	
2.3	Nitrogen (%)	1.83	1.18	1.97	1.15	2.18	
2.4	Oxygen (%) (By difference)	7.87	6.77	8.16	6.72	8.54	
2.5	Sulphur (%)	0.4	0.35	0.5	0.35	0.6	
2.6	Total Moisture (%)	13	15	11	15	10	
2.7	Ash (%)	42	46	35	47	33	
2.8	GCV (kcal/kg)	3300	2800	4000	2700	4200	
2.9	Hard grove index	55	50	70	75	50	
2.10	YGP Index (mg/kg)	75	80	65	60	90	
3.0	ASH ANALYSIS						
3.1	Silica (%)	61.75	61.62	61.82	61.3	61.9	
3.2	Alumina (%)	27.46	27.55	26.9	27.85	26.81	
3.3	Iron Oxide (%)	5.18	5.4	5.1	5.4	5.0	
3.4	Titania (%)	1.84	1.88	1.8	1.88	1.8	
3.5	Phosphoric Anhydride (%)	0.54	0.55	0.54	0.55	0.54	
3.6	Lime (%)	1.47	1.32	1.52	1.32	1.55	
3.7	Magnesia (%)	1.0	1.03	0.97	1.05	0.95	
3.8	Sulphuric Anhydride (%)	0.05	0.05	0.05	0.05	0.05	
3.9	Sodium Oxide (%)	0.10	0.05	0.30	0.05	0.35	
3.10	Potassium Oxide (By Difference) (%)	0.61	0.55	1.0	0.55	1.05	
4.0	ASH FUSION RANGE (Under reducing atmosphere)						
4.1	Initial Deformation Temperature (degree Celsius)	1100	1100	1100	1100	1100	
4.2	Hemispherical temperature (degree Celsius)	1300	1250	1350	1250	1350	
4.3	Flow temperature (degree Celsius)	1400	1400	1400	1400	1400	
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CLAUSE NO.	PROJECT INFORMATION			
	TABLE-2 ANNEXURE-IV-3 HIGH SPEED DIESEL OIL CHARACTERISTICS [AS PER IS 1460-2005 (BS-II)]			
	S. No.	Particulars	Unit	Value
	1.	PHYSICAL PROPERTIES		
		a. Distillation volume recovery @ 350 ⁰ C	% vol. (min)	85
		b. Distillation volume recovery @ 370 ⁰ C	% vol. (min)	95
		c. Kinematic Viscosity @ 40 Degree C	cSt	2.0 – 5.0
		d. Density @ 15 Degree C	kg/m ³	820 – 860
		e. Pour Point		
		- Summer	Degree C (max)	15
		- Winter	Degree C (max)	03
		f. Cold Filter Plugging Point		
		- Summer	Degree C (max)	18
		- Winter	Degree C (max)	06
		g. Flash Point (Abal)	Degree C (max)	35
		h. Lubricity WSD 1.4 @ 60 Degree C	Microns (max)	460
	2.	HEATING VALUE		
		a. Higher Heating Value (HHV)	Kcal/Kg	11,000
		b. Lower Heating Value (LHV)	Kcal/Kg	10,300
	3.	ACIDITY		
		a. Inorganic	mg KOH/g	Nil
		b. Total	mg KOH/g	0.2 (max.)
	4.	Copper Strip Corrosion 3 hours @100 ⁰ C	No.	1 (max)
	5.	RCR on 10% residue	% wt.	0.3 (max)
	6.	CONTAMINANTS		
		a. Ash	ppm (wt.)	100 (max)
		b. Sediments	% wt	0.05 (max)
		c. Total Sulphur	% wt	0.05 (max)
		d. Water Content	% volume	0.05 (max)
		e. Trace Metals		
		- Na + K	ppm (wt)	0.30 (max)
		- Vanadium	ppm (wt)	0.50 (max)
		- Lead	ppm (wt)	0.50 (max)
		- Calcium	ppm (wt)	2.0
		- Ni + Zn	ppm (wt)	Nil
	7.	Nitrogen content (FBN)	% wt.	0.015
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	Table # 3 Not used		
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	ANNEXURE-IV-4			
	TABLE – 4			
	TYPICAL IMPORTED COAL AND ASH CHARACTERISTICS			
	Sl.No.	Characteristics (as received basis)	Imported Coal	
			Worst	Best
	1.0	Proximate Analysis		
	1.1	Total Moisture (%)	20	16
	1.2	Ash (%)	10	10
	1.3	Volatile Matter (%)	30	45
	1.4	Fixed Carbon (%)	40	29
	1.5	Total (%)	100	100
	2.0	Ultimate Analysis		
	2.1	Carbon (%)	56.4	62.4
	2.2	Hydrogen (%)	4.5	4.9
	2.3	Sulphur (%)	0.9	0.8
	2.4	Nitrogen (%)	0.9	0.5
	2.5	Oxygen (%) (By difference)	7.3	5.4
	2.6	Carbonates (%)	0	0
	2.7	Phosphorous (%)	0	0
	2.8	Total Moisture (%)	20	16
	2.9	Ash (%)	10	10
		Total	100	100
	2.10	GCV (Kcal/Kg)	5800	6500
	2.11	Hard Grove Index	45	60
	2.12	YGP (mg/kg)	100	70
	3.0	Ash Analysis		
	3.1	Silica (SiO2) (%)	32.74	34.94
	3.2	Alumina(Al2O3) (%)	30.5	28.43
	3.3	Iron Oxides(Fe2O3) (%)	18.2	15.2
	3.4	Titania (TiO2)	1.56	1.76
	3.5	Phosphoric Anhydride(P2O5) (%)	0.44	0.54
	3.6	Lime (CaO) (%)	6.12	7.62
3.7	Magnesia (MgO) (%)	1.83	1.93	
3.8	Sulphuric Anhydride (%)	6.95	7.65	
3.9	Sodium Oxide (Na2O) (%)	0.3	0.4	
3.10	Balance alkalies (by difference)	1.36	1.56	
	Total	100	100	
4.0	Ash Fusion Temperature reducing temperature			
4.1	Initial deformation Temp (°C)	1100	1250	
4.2	Hemispherical Temp. (°C)	1300	1350	
4.3	Flow Temp. (°C)	1400	1400	

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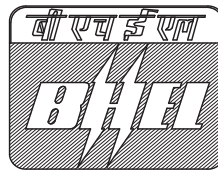
2 X 660 MW

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SECTION C

SPECIFIC TECHNICAL REQUIREMENTS



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2.03.00 EXCLUSIONS

3.00.00 SUBMISSIONS

4.00.00 GENERAL LAYOUT PLAN

4.02.00 TECHNICAL SPECIFICATIONS FOR PLANT WATCH TOWER

4.03.00 SITE LEVELLING AND SLOPE PROTECTION WORK

5.00.00 SALIENT FEATURES & DESIGN CONCEPT OF MAIN PLANT BUILDINGS, CHIMNEY, COOLING TOWERS, CW SYSTEM & MAKE-UP WATER SYSTEM, DM PLANT, PT PLANT & CW TREATMENT CIVIL WORKS, BALANCE OF PLANT BUILDINGS, COAL HANDLING & ASH HANLING SYSTEMS, SWITCHYARD STRUCTURES, FACILITIES FOR RAILWAY SIDING, FUEL OIL HANDLING SYSTEM, OFFICE BUILDINGS, ROADS AND DRAINAGE

5.00.01 ARCHITECTURAL CONCEPTS & DESIGN

5.01.00 ~~MAIN PLANT BUILDINGS/ STRUCTURES / MACHINE FOUNDATIONS~~

5.02.00 ~~CHIMNEY~~

5.03.00 ~~COOLING TOWERS~~

5.03.01 ~~INDUCED DRAUGHT COOLING TOWER~~

5.03.02 ~~NATURAL DRAUGHT COOLING TOWER~~

5.04.00 MAKE-UP WATER SYSTEM

5.05.00 ~~DM PLANT, PT PLANT, ETP & CW CHEMICAL TREATMENT CIVIL WORKS &~~

~~CPU CIVIL WORKS~~

5.06.0 ~~SWITCHYARD CIVIL WORKS~~

5.07.0	~~COAL HANDLING PLANT (CHP) STRUCTURES~~
5.08.0	~~ASH HANDLING SYSTEM & ASH WATER RECIRCULATION SYSTEM~~
5.09.00	~~SEWERAGE SYSTEM~~
5.10.00	~~PLANT STORM WATER DRAINAGE SYSTEM~~
5.11.00	~~DIVERSION OF EXISTING DRAINAGE~~
5.12.00	~~ROADS~~
5.13.00	~~ADMINISTRATION BUILDING~~
5.14.00	~~PLANT AUDITORIUM~~
5.15.00	~~MAIN GATE COMPLEX & CISF BUILDING~~
5.16.00	~~PERMANENT STORE BUILDING~~
5.17.00	~~FACILITIES FOR RAILWAY SIDING AND CHP AREA~~
5.18.00	~~NOT USED~~
5.19.00	~~FIRE WATER PUMP HOUSE, FOAM PUMP HOUSE AND FIRE WATER BOOSTER PUMP HOUSE~~
5.20.00	~~RAW WATER RESERVOIR~~
5.21.00	~~FUEL OIL HANDLING SYSTEM~~
5.22.00	~~O&M WORKSHOP BUILDING~~
5.23.00	~~CANTEEN~~
5.24.00	~~FIRE STATION BUILDING~~
5.25.00	~~DOZER SHED~~
5.26.00	~~AREA PAVING IN MAIN PLANT BLOCK~~
5.33.00	~~OWNER'S CONSTRUCTION OFFICE~~
5.34.00	~~ASH DYKE MAINTENANCE BUILDING~~
5.35.00	~~SEWAGE TREATMENT PLANT~~
5.36.00	~~BALANCE BUILDINGS~~

6.00.00 DESIGN CRITERIA

- 6.01.00 GENERAL
- 6.02.00 LOADING
 - 6.02.01 DEAD LOADS
 - 6.02.02 IMPOSED LOADS
 - 6.02.03 EQUIPMENT, PIPING AND ASSOCIATED LOADS
 - 6.02.04 CRANE LOAD
 - 6.02.05 SEISMIC LOAD
 - 6.02.06 WIND LOAD
 - 6.02.07 TEMPERATURE LOAD
 - 6.02.08 DIFFERENTIAL SETTLEMENT LOADS
 - 6.02.09 ADDITIONAL LOADS
- 6.03.00 CIVIL DESIGN CONCEPTS
 - 6.03.11 DESIGN CRITERIA FOR ASH SILO
 - 6.03.21 DESIGN OF FOUNDATION FOR TG, TDBFP, MDBFP & FAN FOUNDATIONS
 - 6.03.30 BOILER/ ESP SUPPORT STRUCTURES
 - 6.03.38 DESIGN CRITERIA OF RCC FLOORS
 - 6.03.39 DESIGN CRITERIA OF RCC ROOFS:
 - 6.03.40 DESIGN CRITERIA FOR FOUNDATION
 - 6.03.41 COAL HANDLING PLANT STRUCTURES
- 6.04.00 CORROSION PROTECTION

7.00.0 FOUNDATION SYSTEM SOIL DATA AND GEOTECHNICAL INVESTIGATION

- 7.01.0 SOIL DATA
- 7.02.0 FOUNDATION SYSTEM
 - 7.02.01 GENERAL REQUIREMENTS

- 7.02.02 OPEN FOUNDATIONS
- 7.02.03 PILE FOUNDATIONS
- 7.03.0 SPECIAL REQUIREMENTS
- 7.04.0 EXCAVATION FILLING AND DEWATERING
- 7.05.0 SHEETING & SHORING
- 7.06.0 SPECIAL REQUIREMENTS FOR RIVER SIDE/ SUBMERGENCE FACILITIES
- 7.07.0 GEOTECHNICAL INVESTIGATION - ANNEXURE-I
- 7.08.0 APPENDIX A –BOREHOLES

8.00.00 GENERAL SPECIFICATION

- 8.01.01 JOINTS IN CONCRETE STRUCTURES
- 8.01.52 ACID/ ALKALI RESISTANT LINING
- 8.01.53 BITUMINOUS COATING
- 8.02.00 CONCRETE
- 8.03.00 FORMWORK
- 8.04.00 FENCING AND GATE
- 8.05.00 GRATING
- 8.06.00 FABRICATION
- 8.07.00 STEEL HELICAL SPRING AND VISCOUS DAMPERS

9.00.00 ARCHITECTURAL CONCEPTS AND DESIGN

- 9.02.00 GENERAL ARCHITECTURAL SPECIFICATIONS
- 9.03.00 WATER SUPPLY AND SANITATION
- 9.04.00 FLOORING
- 9.04.19 PAVING
- 9.05.00 ACID/ ALKALI RESISTANT LINING
- 9.06.00 ROOF

9.06.06	ROOF WATER PROOFING
9.07.00	WALLS
9.08.00	COLOUR COATED AND OTHER SHEETING WORK
9.09.00	PLASTERING
9.10.00	PAINTING & ALUMINIUM COMPOSITE PANEL CLADDING
9.11.00	DOORS & WINDOWS
9.12.00	GLAZING
9.13.00	FALSE CEILING
9.14.00	INTERIOR DESIGN
9.15.00	FINISHING SCHEDULE
	TABLE A -PROPOSED ACID /ALKALI RESISTANT TREATMENT
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10.00.00 MATERIAL SPECIFICATION

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10.02.00	AGGREGATES
10.03.00	REINFORCEMENT STEEL
10.04.00	STRUCTURAL STEEL
10.05.00	BRICKS
10.06.00	FOUNDATION BOLTS
10.07.00	STAINLESS STEEL
10.08.00	WATER
10.09.00	STATUTORY REQUIREMENTS

11.00.00 INSPECTION, TESTING AND QUALITY CONTROL

12.00.00 ANNEXURES

- a) LIST OF CODES & STANDARDS
- b) CONSTRUCTION METHODOLOGY
- c) BORE HOLE DATA
- d) WIND DESIGN CRITERIA
- e) SEISMIC DESIGN CRITERIA
- f) QA REQUIREMENT
- g) RAINFALL DATA(Hydrological Data)
- h) HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM (for concrete surfaces of IDCT)
- (i) LIST OF TENDER DRAWINGS
- (j) ELECTRICAL RESISTIVITY DATA
- (k) SITE MANAGEMENT PRACTICE DURING CONSTRUCTION PHASE

13.00.00 APPENDIX

- (1) SITE SPECIFIC AREA DRAINAGE STUDY FOR PLANT, ASH DYKE & TOWNSHIP

CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00 1.01.00	GENERAL This specification is to cover, survey works , site leveling works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour & materials and construction of all civil, structural and architectural works by the Bidder. Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein. The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work. All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder. The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works. Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and the borelog data is furnished in Annexure 'C'. Detailed Geotechnical Investigation shall be carried out by the bidder. The foundation system shall be evaluated by the bidder based on the above mentioned detailed geotechnical investigation. The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder's work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer. The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. deptt. As per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works. All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.		
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	Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.			
~~2.00.00~~	~~SCOPE OF WORK~~ Defined separately in part A			
~~2.01.01~~	~~The scope of work for the EPC contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.~~			
2.02	Construction Facilities For details of construction facilities refer to Part-A of this specification.			
2.03	Exclusions: The details of exclusions and terminal points, refer to Part-A of this specification.			
3.00.00	SUBMISSIONS			
3.00.01	The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only. Project design intent document giving the basis of design, which shall cover all the aspects, parameters, assumptions, references, structural idealization / mathematical model, loading cases, load combinations, basis of analysis and design of all buildings, facilities, systems and structures etc. shall be furnished and got approved before commencement of detailed engineering. a) Structural analysis, design calculations and drawings of substructure and super structures for all buildings, structures, facilities, and systems including cooling water ducts/pipes. b) Analysis, design calculations and drawings for all services like roads, culverts, bridges, road/rail crossings, drainage pump houses (if required), drains, sewers, sewage pump house, water supply, water tank, coal conveyor galleries, trestles, transfer points, trenches, ducts, etc. c) Survey drawings indicating spot levels for the area under the scope of work and L-section along pipe corridors outside plant boundary. d) Plant 'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings *and facilities, piping/cable corridors, railway lines, green belt, etc. e) Drawings showing underground facilities with co-ordinates and invert levels of the facilities like buried pipes, buried cables, trenches, ducts, sewers, drains, sumps, pits, culverts, manholes, etc. f) Architectural Design and Detailing aspect of all the Building shall be rendered through professional services of a registered Architect. The Architect consultant shall be of National/ International repute, having experience in similar kind of works. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect. h) All architectural drawings required for execution of construction work such as detail floor plans, detail elevations, detail sections and other miscellaneous architectural			
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	details such as finish schedule(internal & external), colour schemes (both internal and external), doors and windows, flooring details & pattern, north/sky light in the roof, false flooring, false ceiling, etc., architectural facia and projections, miscellaneous stair details & architectural details like, coping, flashing, khurras, water proofing, fillet, roof decking, wall cladding, surface drains, rain water down comers, sanitary, plumbing, etc. i) Design criteria and design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundation for TG, BFP, Mills, Fans (PA, FD, ID & Seal Air), Crusher etc. j) Write-up on various statutory requirements and their compliance for various buildings, facilities, structures and systems, etc. k) As Built- Final Shop drawings/fabrication drawings of all structural steel works(only for reference) on CDs and design calculations for important joints/connections l) Construction and erection procedure for all major structures such as Main Plant building including Control tower, Mill and Bunker building including coal bunkers, Transfer Points, Conveyor Galleries, Boiler/ ESP structures, Chimney, C.W.PH, Intake Water Pump House, Cooling Towers, Switchyard Structures, Ash Slurry PH, Ash Water PH, TG foundation and other machine foundations, C.W. Clarifiers, etc. covered under the Bidder's scope. m) In case of piling, scheme for initial pile load tests in vertical, lateral and uplift modes along with supporting design calculations, scheme of routine load test of piles, High Strain Dynamic Load Test, Pile Integrity Tests and methodology for installation of working piles. n) In case of piling, the design of piles in terms of type, rated capacity, length, diameter and termination criteria to locate the founding level. o) Marking scheme identifying the equipment lay-down areas, with distinctive colour scheme. p) Material test certificates. q) Design criteria (for approval) and drawings (for information only) for Boiler/ESP supporting structures. r) As built drawings with quantities of various items of work system wise, building wise, structure wise, etc. duly certified by Site after execution of work for information/record. s) Details of corrosion protection measures for all structures. t) One complete set of applicable standards, references, specifications, code of practice along with soft copy (wherever required with minimum 2 years license fee) to the Engineer for use at site. u) Wherever applicable, scheme for dewatering, shoring, strutting/sheet piling. v) All other design details/drawings or any other submission as indicated elsewhere in this specification and as required by the Employer. w) In case of Raw Water Reservoir, the design and drawings of reservoir embankment including analysis of slope stability, seepage analysis, inlet and outlet arrangement,			
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	road & spillways along with supporting calculation & methodology of construction & laying of HDPE liner. Commencement of fabrication and erection and construction shall be done after approval of the relevant documents and drawings. All drawings shall be of standard sizes (Metric System) and shall be made on AutoCAD. All documents shall be made using MS office. Bidder shall submit all documents and drawings as per the followings: Drawings: - Soft copy via C-folder for all drawings. - After approval of drawings 6 Hard copies of each construction drawing shall be submitted to Owners site office As Built Drawings: - In CD. Design/Document: - Soft copy via e-mail/ C-folder and two set of hardcopies. In general 3D modeling and structural frame analysis and design for the plant structures shall be submitted by the bidder for Employer's review and approval. Soft copy of 3D modeling (including input and output files shall be submitted All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter wise) and structural steel (section wise).	
4.00.00	GENERAL LAYOUT PLAN	
4.01.00	The preliminary layout plan proposed for the project is shown in the drawing no. 9578-999-POC-F-001 titled "General layout plan". It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope. Bidder shall prepare the detailed layout of the plant facilities which are in his scope and shall submit the same for Owner's approval. While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects. - All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met. - Face of the buildings and facilities are located in such a way so as to have an offset of minimum 20m with respect to centre line of double lane road and 15 metre with respect to centre line of single lane road. - The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant. - The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working parallelly with the Bidder within the plant premises. - The area for construction/erection facilities like lay-down, pre-assembly, offices and stores have been earmarked on the General Layout Plan. - No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks, Hydrogen plant complex, etc., except those permitted by Owner.	
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	g) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed. However the same may be adopted subject to approval of the Employer. h) All the buildings and facilities shall be approachable by fire tenders.			
4.02.00	Technical Specifications for Watch Tower Watch Towers shall be RCC construction with all weather enclosure at 6M height. Watch Towers shall be provided at 600 m interval along the Boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with caged MS ladders.			
4.03.00	Site Levelling And Slope Protection Work			
4.03.01	Complete levelling of entire plant area including the area earmarked for administration building, ash based units, ash silos, railyard and raw water pumphouse and associated facilities shall be done by the Bidder. Filling in reservoir area below the bed of reservoir and for the reservoir embankment shall also be done by the Bidder. Detailed requirements for the same are specified under head 'Raw Water Reservoir' elsewhere in the specifications. Bidder shall carry out the topographical survey before he commences detailed design and site leveling. This survey shall cover the entire plant area including the areas earmarked for administration building, ash based units, ash silos, railyard, raw water pumphouse & associated facilities, reservoir and the diversion drains in Bidder's scope of work. Based on field observations the contractor shall prepare and submit for Owners review the survey maps of the surveyed sited on suitable scale, indicating grid lines, contour lines and demarcating all permanent features like roads, railways, water-ways, buildings, power lines, natural streams, trees etc. For each area two sets of survey maps shall be prepared and submitted, one showing the spot levels and contours with grid lines and the other showing the grid lines, contours and permanent features. Established methods of surveying like triangulation, traversing, fly leveling etc. shall be adopted for the survey work. Spot levels shall be taken at 25 metres interval and at closer intervals where pits, undulations etc. are met with. these levels shall be taken in two orthogonal directions. Contours shall be plotted at 0.5m interval. It is proposed that for the purposes of site leveling the entire plant and associated areas will be divided into various blocks as defined in the drawing no. 9578-001-POC-A-001 titled, "Site Levelling Works ". Each block shall be finished to the formation level as specified in drawing. Bidder shall deploy adequate number of experienced site leveling contracting agency(s) with requisite earth moving and compacting equipment to complete the work as per schedule. Since the construction of roads and drains for the entire plant is included in the scope of Bidder, it shall be the responsibility of the Bidder to ensure that these facilities are also constructed along with site leveling works. Bidder shall ensure that road access and drainage facilities for each block is available when site leveling in that block is completed. Unless otherwise instructed by the Engineers, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block. The specified formation level(s) shall be achieved either by excavation where the existing ground levels are higher than the specified formation level or by raising by controlled filling with borrowed earth where the existing ground levels are lower than the specified level.			
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	The excavation shall be in all types of soils or rock or a mixture of these. Bidder should assess and satisfy himself about the actual nature of soil present at site, before submitting his bid. All materials arising out of site clearance and excavation shall be the property of owner. They shall be dealt with in the manner specified by the Engineer. Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material. Other materials like twigs, leaves, roots, vegetable and organic matters etc. shall be termed as unserviceable material and shall be sorted out from the serviceable materials before disposal. They shall be cleared from the area and disposed off at places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. If the excavated material is suitable and accepted by the Engineer as fill material, the same can be used for filling in other areas where raising by filling is required. Otherwise the same shall be taken and stacked at places(s) within the plant boundary as directed by the Engineer. Filling with rock shall be done only after the written permission of the Engineer in the following manner: - Filling with rock shall be done only in areas identified for laydown and preassembly and ash based units. - Original ground after removal of all organic and vegetable matters shall be consolidated by rolling as directed by the engineer subject to a minimum of six passes of 8-10 tonnes roller. - Excavated rock shall be laid (on original ground or after filling 300 mm thick layers of soil as specified), in layers not exceeding 1000 mm and rolled with vibratory roller (10-15 tonnes static weight) with minimum six passes. - Over the compacted layer of rock, soil shall be filled in horizontal layers not exceeding 300mm in compacted thickness. The soil shall be compacted as specified elsewhere. - It shall be ensured that the top soil layer is in minimum 3 layers of 300 mm each. To achieve this the thickness and number of rockfill layers below can be suitably adjusted. Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. "9578-001-POC-A-001. However, Owner does not lake any responsibility about the accuracy of the survey details furnished and any variation of the said data shall not constitute a valid reason for changing the terms and conditions of the contract. Bidder is requested to carry out his independent assessment of the existing ground levels before furnishing his. bid Detailed survey shall be carried out by Bidder after award of work and all findings as stated earlier shall be submitted for Owner's review.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
4.03.02	All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding within the limits of overall land acquisition line and in adjoining areas.		
4.03.03	Before commencement of cutting/filling, all organic and vegetable matters like grass, plants shrubs bushes, weeds, trees etc. in the areas to be filled, shall be completely removed along with their roots and disposed off. It shall also be ensured that the area to be filled is clear of any water, slush etc. Original ground shall be compacted by rolling as directed by the Engineer subject to a minimum of six passes of 8 to 10 tonne roller. The earth shall then be spread in horizontal layers not exceeding 300 mm in compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction of 95% or more of Standard Proctor's maximum dry density. The moisture content of the fill material shall be controlled to obtain near optimum moisture content during compaction. The fill material shall be tested for determining optimum moisture content and maximum dry density by Standard Proctor Test as per IS : 2720 (Part-VII). The fill material shall also be tested for determining moisture content before compaction as per IS:2720 (Part-II). For each of the above tests, one sample for every 10,000 cubic metre of fill material shall be tested. Additional samples shall be tested, whenever there is a change in the source or type of fill material. The compacted soil shall be tested for its dry density as per IS2720 (Part-XXIX) or Part-XXVIII). Samples shall be taken at the rate of one sample for every 10,000 sq.m. area for each compacted layer. In addition random checks shall be carried out in compacted soils by means of Proctor needle penetration. Bidder shall submit to the Engineer, the test results immediately after completion of the tests. A sample shall be deemed to have passed the test when the in-situ dry density is equal to or more than the specified percentage of maximum dry density. If a sample taken from a layer fails to pass the test, the layer shall be further compacted till two samples taken and tested from this layer pass without any negative deviation. Only after this, spreading of further layers shall be taken up.		
4.03.04	Before start of filling, the Bidder shall submit to the Owner his proposal for the methodology to be adopted for compaction for each type of fill material. The Bidder shall also carry out compaction trials to establish the proposed methodology. The Bidder shall start the compaction work only after approval of the methodology by the Owner		
4.03.05	The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally.		
4.03.06	The borrow areas outside the overall plant boundary limits for obtaining suitable fill material which is required over and above the earth available after cutting high grounds within the plant area, for site levelling shall be arranged by the Bidder himself and all expenses in respect of royalties, taxes, duties, etc. for borrow areas/fill material shall be borne by him. He shall also obtain and submit to the Owner the necessary clearances/permission from the concerned authorities for the borrow areas/fill material.		
4.03.07	Material suitable for filling shall be loaded and transported to the filling site by the Bidder. Any coarse grained or fine grained low plastic soil, free from shingle, salts, organic		
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	matter, sod or any other foreign substances, may be used for filling. The Bidder shall test the fill material to establish its suitability and submit its results to the Owner. Fill material shall be approved by the Owner. The following types of materials shall not be used for filling: a) Material from swamps, marshes and bogs. b) Expansive clays c) Peat, logs, stumps, sod and perishable materials. d) Materials susceptible to combustion e) Any material or industrial and domestic produce which will adversely affect other materials in the work. f) Materials from prohibited areas			
4.03.08	Bidder shall include in his offer any extra filling that may be required on account of subsidence of the original ground due to overburden of filling above and/or compaction works for site levelling.			
4.03.09	After levelling, the contractor shall establish concrete pillars at the intersection points of the grid lines for future reference. These pillars shall project at least 450 mm above the formation level and shall be labeled permanently with their respective coordinates and reduced levels.			
4.03.10	Filling upto the specified formation level shall extend at least 2.0 m beyond the outside face of boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical: 2 Horizontal) and provided with good quality dry stone pitching minimum 300mm thick.			
5.00.00	SALIENT FEATURES & DESIGN CONCEPT OF MAIN PLANT BUILDINGS, CHIMNEY, COOLING TOWERS, CW SYSTEM & MAKE-UP WATER SYSTEM, DM PLANT, PT PLANT & CW TREATMENT CIVIL WORKS, BALANCE OF PLANT BUILDINGS, COAL HANDLING & ASH HANLING SYSTEMS, SWITCHYARD STRUCTURES,FACILITIES FOR RAILWAY SIDING, FUEL OIL HANDLING SYSTEM, OFFICE BUILDINGS, ROADS and DRAINAGE			
5.00.01	Architectural concepts & design a) Architectural Design and Detailing aspect of all the Building shall be rendered through professional services of a registered Architect. The Architect consultant shall be of National/ International repute, having experience in similar kind of works. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View & 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect b) Power Plant Buildings shall be architecturally treated, based on functional			
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	requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehensible scale, blending colour scheme with the surroundings. c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction. d) Overall colour scheme of the Main plant building and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements. e) For adequate light and ventilation, National Building Code recommendations shall be followed. Main Power House Building shall have skylights in polycarbonate sheet in each bay on T.G Hall Roof, so as to provide adequate natural light inside. All buildings having height more than 4.0 m shall have glazed ventilators. f) Architectural design of Main Power House Building, Administration Building, Service Building, Workshop, O&M Store, ESP control Building & Switchyard control building shall be suitable for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose. g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations & incorporating sustainable building design features like energy efficiency, Solid waste management, water conservation and recycling, use of local material etc. h) During design stage, Technical specification as prepared shall govern the finishes. i) Service building, Administration building, and Canteen building shall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building, with a minimum Three (3) star rating. Bidder shall perform all services related to GRIHA certification including preliminary assessment, GRIHA facilitation, simulation & analysis leading to obtaining the final certification by GRIHA. For information about GRIHA, bidder is requested to visit the web site www.grihaIndia.org j) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons. k) All the buildings and site development including landscaping shall be designed to take care of Rain water harvesting & Ground water recharging. Development of rain water harvesting scheme for the project and obtaining approval of the scheme			
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5.01.00	from Central Ground Water Board is in Bidder's Scope. l) For Control Rooms of MPH/ ESP Control Buildings, Dry Wall Construction Technology shall be incorporated. m) Overall emphasis shall be on developing eco-friendly architecture, merging with the nature with its own sustainable energy management systems. Ecofriendly architecture means design and constructions that are eco-friendly and helps to save the natural resources of the earth. Eco friendly architecture saves energy and completely natural materials are used. Solar heating and passive cooling, natural materials, daylight and fresh air, water conservation including ground water recharge and rain water harvesting sun are the specialty of this type of architecture. The above definition is only indicative and the bidder shall incorporate the above features into design and construction to achieve a sustainable, eco friendly architectural design for the whole project. n) Landscape Development There shall be comprehensive landscape development in entire Plant area to create a pleasant and healthy environment. The scope of work for landscape and horticulture work shall include supply and planting of trees, shrubs, hedges/edges/borders, grass lawn around different areas, buffer and peripheral plantation etc. The scope shall also include supply and installation of all landscape furniture i.e. Park-Benches, & Gazebos, Landscape fountain & water bodies, Landscape Pavers/ Tiles etc & all associated electrical works/ items, Mechanical works/items and civil works and all other work required for completion of Landscape development. The landscape design and drawing shall be developed by competent Landscape Architect. The landscape shall use the suitable plants and trees preferably local trees, plants, and shrubs. There shall be provision of pathways in and around the landscaped area. Around the pathways and roads, trees shall be planted. There shall be provision of drip/sprinkler irrigation system for irrigation of landscaped area. There shall be intense landscape with four water body development one each near Main gate complex, Administration building, Service building and Canteen building. Minimum size of water bodies shall be as given below: Administration Building and Service Building – 5.5m diameter and 1.0m depth Canteen Building and Gate Complex – 3.0m diameter and 1.0m depth The landscape (including water body) around Administration Building, Service Building, Auditorium Building, and Canteen building shall meet the GRIHA requirement for 3 STAR rating.			
	~~Main plant Buildings/ Structures shall comprise of.~~ a) Main Power House b) Mill Bunker Building c) Transfer Points , Conveyor Galleries & Trestles d) Machine Foundations in Main Plant e) Boiler Structure f) Air Washer Building			
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	g) Compressor House h) ESP Structure i) ESP Control Building j) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level. k) Pipe & Cable Gallery l) Service Building The Main Power house, Bunker building, transfer points, conveyor galleries and trestles, boiler supporting structure, ESP supporting structures including inlet and exhaust duct support structures, Pipe cable Galleries & trestles shall have structural steel framed super structure. All other buildings may have either RCC or structural steel framework. Brief description of the above mentioned Main Plant Building is furnished herein:- a) Main Power House (i) Salient Features: Main Power House shall consist of the Turbine bay, adjacent Deaerator Bay, electrical bay & Common Control room Building (CCR Building), (as stipulated elsewhere in this specification). The Turbo – Generator (TG) foundation, MFBFP & TDBFP foundations which shall have top RCC deck and shall be located inside the power house and their foundation system shall be as per design concept of machine foundation. All other equipment foundations (including Heaters & Deaerators) shall be supported on RCC floors with structural steel beams. The RCC floors shall comprise RCC slab over profiled metal deck sheets (to be used as permanent shuttering over structural steel beams). Shear anchor studs shall be provided through metal deck at regular interval on all top flange / flange plate of structural beams. However, steel gratings, chequered plate flooring as well as precast RCC covers shall be provided as per the functional requirements. All RCC pits & trenches below ground floor slab (including CW pit & CEP pit) shall be covered with minimum 40 mm thick MS grating supported on structural steel beams. The RCC pits shall also be provided with a sump at the corner for dewatering with submersible pumps. Staircases & ladders shall be provided for access to these pits. EOT cranes shall be placed in the Turbine Bay with the Gantry Girders (supporting Crane Wheel Loads) supported on structural steel brackets on A & B row columns). Walkway with chequered plate shall be provided at crane girder level at both 'A' row & 'B' row side with caged ladder access from the operating floor. All columns & beams of Main Power House shall be of structural steel girder (open web or solid web) with base plate level of columns 1.20m below ground floor slab level in general except for CW pit and other pit areas where structural steel column shall be extended below upto a depth lower than the pit top surface such that the column base plate & stiffeners are concealed below the pit raft level. The roof system in Turbine bay shall comprise a structural steel girder (open web or solid web) for the entire bay width. The roof slab shall consist of 40mm thick (min.) RCC slab supported on profiled metal deck sheet. The metal deck sheet shall be supported on structural steel purlins. The purlins shall be in turn be supported on turbine bay roof girder top chord at regular interval. Additional waterproofing shall be provided above the roof RCC slab		
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	as per details mentioned elsewhere in this specification. 1 in 100 slope shall be provided for the turbine bay roof sloping downwards towards the A-row (towards transformer yard) . Minimum 150mm dia galvanized mild steel pipes shall be used at A-row & C-row as Rainwater Down comers. Staircases in main power house shall be of structural steel. Treads & risers of each staircase shall be 40mmthick MS grating and handrail/ hand post shall be 32mmNB circular hollow sections unless specified otherwise in architectural section of the specification. All staircases in Turbine Bay and Deaerator Bay shall be enclosed with 230 thk brick masonry Wall with fireproof doors at all floor landing levels. Skylight structure on Turbine bay roof shall be provided at regular interval for natural lighting. The parapet wall shall be of minimum 1m height and shall be provided all the around roof of main plant building. All edges of openings shall have edge protection angles (minimum ISA 75x75x6) and handrails with hand posts (Hand post spacing 1.50m maximum). The vertical cladding system for this completely covered Main Power House building shall comprise brick masonry / Aerated Autoclaved Concrete (AAC) block masonry/ AAC panel wall & metal sheets as mentioned in the Architectural Features. ii. Design Concept: Main Power House shall be designed as moment resisting sway frame in the transverse direction and braced in the longitudinal direction. However, due to functional requirement, vertical bracings to the Control Room Building column may not be possible at (& above) the operating floor level and in such case, control room frames shall be designed as moment resisting frames in both transverse and longitudinal directions) All beam column moment connections shall be designed for adequate ductility. The building shall have connectivity with walkways from Boiler & Service Building through PTFE bearings (sliding bearing) only. The connectivity with cable gallery shall be as specified in Pipe & cable gallery section of this chapter. Floor level acceleration spectra shall be generated during seismic analysis for design of pipe supports / equipments located at the elevated floors. Adequate number of thermal expansion gap (minimum 1.50m between adjacent structural frames at expansion joint and minimum 50mm between RCC slabs at expansion joint) shall be provided between the units and Common Control Building. In the RCC floor/ roof slabs, the spacing of shear anchor studs on structural beams shall be minimum of the spacing required for i) the restraintment of compression flanges of beams and ii) transfer of the horizontal shear at floor/roof to the supporting beams. The roof girder in Turbine Bay shall be provided with a camber to take care of deflection due to dead weight. The Main columns in A, B & C rows of Main Power House Building shall be built-up I sections. Rolled sections/ I sections with additional flange plates shall not be acceptable for main columns & auxiliary columns. The roof truss to column connection shall be bolted connection using high strength bolts (grade 8.8/ IS 1367). The roof truss of Turbine Hall shall be adequately braced in plan using Tie Level and Rafter Level Bracings. The longitudinal bracing shall comprise a pair of Box sections welded to the column flanges and detailing shall be adequate to restrain the entire column cross- section. Minimum gusset plate thickness for bracings shall be 12mm. The base plates of Main Columns in A, B, & C rows shall be grillage type of minimum depth 800mm and comprising bottom base plate, top cap plate & interconnecting vertical stiffeners.		
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	The Control Building structure shall have large span roof girders for the roof structure of main Control room such that no internal column within the control room floor exist. The external walls of the Control Building shall comprise of autoclaved aerated concrete panel attached with vertical metal sheeting on the external face. The space between the false ceiling and beams of the roof slab of Control Room shall be divided into several compartments by brick wall /aerated concrete panel wall for inert gas partitioning. Due to functional requirement , longitudinal bracings to the Control building column may not be possible at (&above) the operating floor level and in such case, star- sectioned structural steel columns shall be provided and these columns shall be designed for biaxial bending. All handrails in front of the control room shall be made of stainless steel. Foundation and RCC pedestal for last grid of main power house columns (second unit) shall be designed and constructed to accommodate twin columns with expensive gap of 1.5 m. For all other design methodology, refer to Design Criteria specified elsewhere in this specification. Architectural Features This building shall be of Structural Steel Framed structure and shall be completely covered with external cladding and RCC roof. The external vertical face(herein stated as 'A' row) of Main Power House facing (& adjacent to) the transformer yard and also the two gable ends shall be completely covered with vertical cladding comprising 3.0m high brick wall (on Ground floor slab) and single skin profiled vertical metal sheet for the remaining height except for the vertical segment between operating floor & Gantry girder bracket level where double skin vertical metal sheet shall be provided. In front of the Generator Transformer, RCC wall upto a height 600mm above the highest point of generator transformer shall be provided in lieu of brick wall & A-row. The above mentioned RCC wall shall be attached with single skin metal sheet on external face. The 'A' row & Gable End columns projecting inside the turbine hall shall be concealed with single skin profiled metal deck sheet from operating floor level to crane girder bracket top level The external vertical face (herein stated as 'C' row) facing (& adjacent to) the Boiler area shall be completely covered upto the Deaerator floor level with vertical cladding comprising 3.0m high brick wall on Ground floor followed by either single skin metal sheeting with runners or brick wall sand witted with single skin metal sheeting on external face(for all floors requiring 4 hrs of fire rating eg Cable Spreader room, Ventillation/ Air Washer Room & AHU Rooms) The internal vertical interface plane between Turbine bay & Deaerator bay (herein stated as 'B' row shall have brick masonry Wall from RCC roof slab level of turbine bay (AB bay) upto specified floor level below such that Turbine bay & Part of Daerator bay below the Deaerator supporting floor level is completely covered on all sides. Glazing for A Row, C Row & Gable end shall be Reflective-6mm thk clear toughened glass with Aluminium frame. Hermetically sealed double glazing shall be provided between A/C areas & non-A/C areas. Light Weight Aerated Concrete Panel with Single Skin Metal Panel cladding shall be provided in exterior of UPS Battery room area and Control Equipment Room area. Inside the main power house building, brick masonry wall (and fire proof doors) shall be provided for switchgear rooms, cable spreader rooms, MCC rooms, AHU rooms, Air Washer room & Oil rooms and all other rooms where fire protection is envisaged.			
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	Cut-outs and opening shall be provided in floors and walls as per functional requirement. For adequate Natural light in TG Hall, adequate no. of North lights with minimum 6 mm thick Reflective-clear Toughened Glass shall be provided in TG Hall Roof. All door, windows in air conditioned area and all windows glazing shall be provided with Aluminium frame work Steel door and Fire Proof doors shall be provided as per requirements. Each unit shall have minimum 1 nos. of passenger lift of capacity 13 persons in BC way, Stairs in BC Bay and on A-Row shall be provided as per functional requirement and as per National Building Code and factories Act. All stairs in BC Bay lift lobby Area shall be in RCC. Stainless steel railing shall be provided at TG Floor level for all cut-outs/ openings and stairs & M.S. railing shall be provided for all other locations. For each unit minimum one no. Gent's toilet with adequate facilities including Drinking water space and Janitor's space shall be provided at each level of Power house Building, in addition one no Ladies toilet shall be provided in each unit at 0.60M and 8.50M level and control room Level. B Row portion in TG Hall fronting Control Room & CER shall be of Hermitically Sealed Double Glazed partitions up to false ceiling level and wall above up to 24.0 M, finished with Decorative murals in Glass Mosaic Tile. Control room/ Control Equipment Room, False Ceiling shall have Cat Walk Way above for service/ maintenance. Adequate partitioning as per functional requirement above false ceiling in control Room & CER shall be provided for Inert Gas zoning. Internal steel columns in Air Conditioned Area of Main Power House Building shall be encased with Aluminium Composite Panelling up to false ceiling. Functionally the very heart of Power House Building is its Control Room. Special attention shall be given for conceptualisation of interior design of the Control Room. Metal Panel Cladding shall be composed of Different Colour shades to match with the surroundings. External finish of Masonry wall, shall be Resin Bounded Granular Texture finish. b) Mill and Bunker building Salient Features The mill bunker building shall house coal mills, feeders, Cylindrical Coal Bunker & Conical Hopper, Tripper Conveyor & its drive and monorails. All columns, main beams and secondary beams shall be made of structural steel. The RCC floor slabs(supporting the Feeder and Tripper Conveyors) shall comprise RCC slab supported on profiled metal deck sheet(to be used as permanent shuttering) not to be considered for design of RCC slab as composite slab) and shear anchor studs welded to the top flange plate of secondary & main structural steel beams, (which supports the RCC slab & metal deck sheet). Structural steel platform cage ladder and walkway (with MS grating and hand rails) shall be provided above the feeder floor for access to the bunker coal level monitoring strain gauges.		
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	The bottom level of base plates of columns shall be 1.20 M below the finished floor level of ground floor of Main Power House. The columns of Mill-Bunker building shall consist of built up structural steel I-sections. Rolled sections with additional cover plates on column flange shall not be acceptable for column sections. The base plate of main columns of the Mill bunker building shall be grillage type (minimum 800 depth) consisting of bottom base plate, top plate and vertical stiffeners. The cylindrical coal bunker and conical hopper shall be made of structural steel. The inside surface of hopper shall be lined with stainless steel plates the details of which are mentioned hereafter in this specification. Structural steel brackets with PTFE bearings shall be provided at the end columns to support the external gallery of the Tripper Conveyor All walkway bridges connecting the Boiler with Mill Bunker building shall have PTFE bearings, in case the Mill-Bunker building is designed as structurally independent of the Boiler structure. The Mill-Bunker building shall be provided with insulated sandwiched metal sheet roofing comprising of troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. The RCC floor supporting the Tripper Conveyor shall be fully covered upto the Roof level with single skin metal sheet(& structural steel runners). The Mill –Bunker Building shall be structural steel frame super structure. The columns shall be braced in both the transverse and longitudinal directions. In the transverse direction the bracings may be waived above the Tripper Floor and near the Ground Floor due to functional requirement. The bracings in the longitudinal direction shall be in 2 planes through a pair of longitudinal members laced (or battened) together. Each bracing member shall be connected to column flange plate through gusset plate (minimum 12mm thick). Bidder has the option to provide the Mill- Bunker Building independent of the Boiler supporting structure or integrate this building with the Boiler structure. i) Design Concept The Mill Bunker Building shall be conceptualized as moment resisting frames in transverse direction and as braced framed in longitudinal direction. In the transverse direction the bracings may be provided, wherever feasible, in order to meet the deflection requirement specified in clause 6.03.07 of this section. The bracings in the longitudinal direction shall be in 2 planes through a pair of longitudinal members laced (or battened) together. Each bracing member shall be connected to column flange plate through gusset plate (minimum 12mm thick). Minimum thickness of structural steel Bunker plates shall be 12mm inclusive of 4mm corrosion allowance. Minimum wall thickness of Hopper shall be 8mm. Minimum thickness of stainless steel liners on the inner surface of hopper wall shall be 4mm conforming to grade SS304. To ensure smooth flow of coal, the hopper surface shall be provided with minimum angle of 73° with the horizontal plane.		
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	The top of the cylindrical bunker shall bear no load/ reaction from the tripper floor and accordingly neoprene bellow strap shall be provided at the interface between the two structures to allow free deflection of the tripper floor. Neoprene bellow strap shall be provided all-round the bunker to effectively seal the gap between top of bunker and sealing plate below bunker. For all other design methodology, refer to Design Criteria specified hereafter in this specification. Architectural Features: The Mill & Bunker Building shall be a structural steel framed structure having RCC floors and prefabricated insulated metal sandwiched sheet sloped roof. The tripper floor side cladding shall be Single skin Metal cladding with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. Rainwater down comer shall be of galvanised MS pipes and shall be located at every column location. c) Transfer Points and Conveyor Galleries Transfer Points The transfer points shall be framed structure of structural steel work having RCC floors (supported on structural steel beams) and prefabricated insulated metal sandwiched sheet sloped roof. The RCC floor slabs shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering not to be considered for design of RCC slab as composite slab) and Shear anchor studs shall be provided with stud welding through metal deck at regular interval on all top flange / range plate of structural beams which support the RCC slab. The side cladding shall be Single skin Metal cladding (from lowest working floor level till roof top) with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both sides. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. Contractor shall have option to use Tubular steel sections for vertical & horizontal bracings. Horizontal bracings at all platforms level shall be designed as beam carrying axial force and bending moment to take care of loads from platforms for maintenance and Gravity Take-up. Brackets and beams for supporting the Conveyor gallery portal shall be provided at required elevation on columns of Transfer Point. Grade slab shall be provided for all transfer point houses. Steel doors and sliding steel doors of required sizes as per system requirement for personnel access and handling of equipment respectively shall be provided. Transfer points shall be provided with insulated, sandwiched metal sheet roofing comprising of troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. For TP's in Main Plant Area, each down comer shall lead the water / coal slurry into the RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into		
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	R.C.C drain(RCC drains with steel gratings provided around the TP), which will lead the discharge finally into plant effluent drain routed alongside the nearby road. Last TP and main plant area shall be designed and constructed to take care of loads due to future expansion of conveyor gallery. Conveyor Galleries and Trestles Troughed belt conveyors in Main Plant Area shall be housed in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification. The maximum span of conveyor gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Contractor can also use tubular steel sections for conveyor galleries and supporting trestles. The tubular steel section shall be of circular/rectangular/square shape. The circular steel tube shall conform to IS 1161 and rectangular/square steel sections shall conform to IS 4923. The steel structures using tubular sections shall be designed and fabricated as per IS 806 – “Code of Practice for use of steel tubes in general building construction.” and EN 1993-1-8:2005. For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be of chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10°, chequered plate steps with nosing and toe guard shall be provided. Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere. Conveyor gallery supporting trestles located between transfer points / buildings shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and		
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	the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements. End of conveyor gallery which will be supported over transfer point, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer point structure and vice - versa. For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and under ground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns base shall be kept 1.2m below the finished floor level of ground floor of Main Power House. d) Machine Foundations in Main Plant Area Salient Features The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials, springs & viscous dampers. Turbo- Generator (TG) foundation: Alternative-1 The TG foundation shall comprise RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns. These TG columns can be interconnected to the Main Power House Building frame either rigidly or connected through PTFE bearings on corbels/ brackets of the TG Columns. The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on TG Equipment detail of the Bidder. Alternative-2 The TG foundation shall be conventional machine foundations comprising of RCC top deck directly supported on substructure comprising of columns and beams without any steel helical springs and viscous dampers. The columns shall be rigidly connected to the RCC deck at top and shall rest on open / pile supported foundation at bottom. The entire foundation system (including deck, columns and raft) shall be isolated from the main plant building structural system and no connection between the main plant structure and TG foundation is permitted. Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.		
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	TDBFP & MDBFP foundations: Alternative-1 TDBFP&MDBFP foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers inside Main Power House. In case the top deck is located at operating floor/mezzanine floor level, the springs/ viscous dampers shall be supported on a group of structural steel columns-beam grid which shall be rigidly integrated with the Main Power House Structural frame. Alternative-2 TDBFP&MDBFP foundations shall consist of RCC top deck directly supported on structural beams and columns without any steel helical springs & viscous dampers inside Main Power House. The structural columns and beams supporting the TDBFP / MDBFP shall be independent of the Main Power House Structural frame and shall also have independent foundation without any connection to other nearby foundations. Further each TDBFP / MDBFP shall have independent supporting structural arrangement without any interconnection among themselves. Bidder has the option to choose either Alternative-1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system. BFPs in ground floor In case the MDBFP/TDBFP foundation is envisaged to be located at ground floor of Main Power House, then these shall be designed as block foundations directly resting on soil / pile. Vertical facing of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS:4671 with density 20 Kg/Cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round. PA/ FD/ID Fan foundations: Alternative-1 These fan foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers. The springs & viscous dampers shall be in turn supported on RCC sub-structure which shall be supported below Ground level. Alternative-2 These fan foundations shall consist of RCC top deck supported on RCC sub-structure which shall be supported below Ground level either with open or pile foundation. Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system. Coal Mill foundation: Coal Mill foundation shall be RCC block foundation directly resting on virgin soil below Ground level. The vertical faces of this block foundation shall be isolated from adjacent		
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	footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round. Design Concept: a) For the foundations of Turbo-generator, Boiler feed pumps, Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done. b) The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbo-generators, ID/PA/FD Fans, BFP, etc., c) Springs and dampers of the vibration isolation system shall be located minimum 300 mm above the finished floor level for ID/PA/FD fans. Basements/pits/trenches shall not be provided for these machine foundations. d) Wherever alternative-2 is adopted by the bidder for TG or BFPs or FAN foundations, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations. e) The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid. For detailed specification of steel helical springs and viscous dampers refer General Specification Chapter. e) Boiler Structure The Boiler supporting structure shall be structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions. The general arrangement & details of structural steel columns, beams, bracings, ceiling girders etc shall be as per the Bidders Boiler Structure design and detailed engineering scheme. The bottom base plates of Boiler structure columns shall be 1.20m below the finished paving level in the Boiler area. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns upto at least 350mm above the top of the paving RCC slab. The bidder shall have the option to design the Boiler structural steel superstructure as an isolated structure or structurally integrate it with the Mill-Bunker building superstructure based on Bidder's design practice. (i) Design Concept: Boiler supporting structure shall be designed by the Bidder based on working stress method for structural steel and IS : 456 for RCC.			
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	f) Air Washer Building (i) Salient Features Air washer Building shall be a structural steel framed structure. The building shall be completely covered with vertical cladding and roof system. The roof shall comprise minimum 40mm thk RCC slab supported on profiled metal deck sheets and structural steel beams. The size, height, monorail details and building co-ordinates shall be as per the approved equipment layout plan of the bidder. (ii) Design Concept: The Design of Air Washer Building shall be based on the working stress method for Structural Steel & IS 456 for RCC. For design requirement, refer to 'Design Criteria' specified elsewhere in the specification. Architectural Features: This building shall be Steel Framed structure. The vertical external cladding shall comprise of 230mm thk brick wall for full height and shall be sandwiched with single skin metal cladding on external face. Roof of the building shall be RCC slab over profiled metal deck sheet. Toilets shall be provided as per requirement. All windows shall be provided with Aluminium Panel frame, Steel Doors & fire proof Doors shall be provided as per functional requirement. Cutouts and opening shall be provided in floors and walls as per requirement. Metal Panel cladding shall be composed of different colour shades to match with the existing surroundings. External finish of Brick wall shall be of Solvent based paint. The rainwater down comers shall be as per architectural specification and they shall be concealed inside the cladding g) Compressor House (i) Salient Features: The compressor house shall be a structural steel framed superstructure with a hand operated overhead crane of required capacity. The gantry girder for the crane shall have walkway with chequered plate on both rows and cage ladder access. The roof shall comprise minimum 40mm thk RCC slab (with additional water proofing) supported on profiled metal deck sheet and purlins. The ground floor slab shall comprise of all RCC block foundations, cable trenches and pipe trenches. The building shall be completely covered with vertical cladding and roof. (ii) Design Concept: The Design of Compressor House shall be based on working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification.			
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	Architectural Features This building shall be steel framed structure with brick wall up to window sill height & Single Skin Metal Panel cladding above it. The roof system shall be as per the detail furnished in the salient features of this building Cutouts and opening shall be provided in floors and walls as per requirements. Metal Panel cladding shall be composed of different colour shades to match with the existing surroundings. External finish shall be of Solvent based paint. The size, height, door/window/rolling shutter details and building size shall be as per the approved equipment layout plan of the bidder. h) ESP structure: (i) Salient Features The ESP structure shall be a structural steel superstructure with vertical bracings in the required vertical planes in both longitudinal and transverse directions, the details of which shall be as per the approved ESP equipment GA & details of the bidder. The bottom level of base plate of the structural columns shall be kept such that, the top of gusset plate / top of bolts shall be at least 200mm below the top of finished floor level. The gusset plate / base plate shall be encased in concrete upto the bottom of the floor slab. The RCC pedestals of the columns shall be extended upto at least 350mm above the ground floor slab for encasement of the columns. (ii) Design Concept: Design of ESP structure shall be based on Working stress method. It shall be an axially braced structure in both orthogonal directions. The ESP supporting columns shall be suitably strengthened about the minor axis for sliding movement of the base plate of ESP due to thermal movement. i) ESP Control Building (i) Salient Features ESP Control Building shall be structural steel superstructure with RCC floors at ground floor level and upper levels. The RCC floors at upper levels shall support the Switchgears, cable galleries and Control Room. The RCC floors at upper levels shall be cast in situ RCC slabs supported on profiled metal deck sheet and structural steel beams. The roof of the building shall comprise of minimum 40mm thick RCC slab supported on profiled metal deck sheet and structural steel beams. The rainwater down comers shall be as per specification and shall be suitably concealed. The external Transformer Yard of the building shall comprise the transformer foundations and cable slit below ground level. The building shall have Lift structure with lift pit below ground level and staircase at each gable end of the building.		
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	(ii) Design Concept The Design ESP Control Building shall be based on Working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification. However, bracings in any internal axis may not be possible due to functional requirement and columns in that row shall be designed for biaxial bending Architectural Features: This building shall be Double storeyed Steel Frame structure & shall be completely covered with Light Weight Autoclaved aerated concrete panels on all four sides except for the portion in front of the external Transformer Yard. Provision for glazed/ fire proof doors & windows shall be included. Minimum 345mm thk brick wall shall be provided for the external brick wall facing the adjacent transformer yard and the brick wall height shall be 600mm above the highest point of the transformer. Inside the building, AHU rooms, UAF Room & Battery rooms shall have brick masonry of one brick thickness. Entire transformer yard, which shall be adjacent to the building, shall be provided with metal fencing with gates. The building shall accommodate cable vault, toilet, staircase, switchgear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Control room and VFD room shall be air-conditioned and shall have false ceiling. Windows & Ventilators all shall be provided with Aluminium sections. All doors, windows in air conditioned area shall be provided with hermetically sealed toughened glass glazing in Aluminium frame work. Steel doors and Fire proof doors shall be provided as per requirements. Internal columns in Control Room shall be encased with Aluminium Composite Panel cladding/ Laminated Board Paneling. Minimum 2 Nos. of stairs and 2 Nos. of Toilets shall be provided as per requirement. Cutouts and openings shall be provided in floors and walls as per requirements. External finish shall be of solvent based paint. j) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level. k) Pipe & Cable Gallery (i) Salient Features: The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick MS grating and 1.0m high handrail made of 32NB MS pipes. Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum		
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	gusset plate thickness shall be 8mm for all connections. The level of the bottom chord(bottom of steel) of the gallery shall be at least 3.0m above the finished paving level in general. However, at all road crossings, the level of bottom of steel of the gallery shall be atleast 8.0m from the top of road surface. The Caged structural steel ladder shall be provided at an interval of 200m for access to the Pipe-Cable Gallery Walkway. The total length of pipe-cable gallery shall be between 4 km & 8km approximately depending on the plant layout developed by the bidder. Suitable expansion gap shall be provided in the gallery structure by providing twin two-legged trestles at the expansion gap. The expansion gap shall be provided at an interval of 100 to 120m. Expansion gap shall also be provided at location where changes in plan dimensions (gallery width) take place abruptly. At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 100m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from center line of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure. The foundation for Pipe-Cable gallery trestles shall comprise RCC pedestals with footings. The footing base shall rest on virgin soil. In case virgin soil depth is high, the gap shall be filled with PCC (M10 grade). The grade of concrete for RCC footing & pedestals shall be M25. The structural trestles shall not be supported on paving RCC slab. (ii) Design Concept: The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter. The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth. The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level (on top of the trestle column). Deflection of end portal due to wind shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly. I) Service Building This building shall be an RCC structure having RCC frame with RCC floors and roof slab. For the building, floor-to-floor height shall be as per architectural features. A connecting corridor with MPH building shall be provided at operating floor level. The building walls shall comprise aerated concrete blocks from ground floor to roof level. The grade of concrete for RCC frame (including foundation) shall be M25. Architectural Features This building shall be Five storeyed (Ground +4 stories above) and shall be provided with floor area of 4500 sq.m with RCC framed structure. Autoclave Aerated Concrete Block masonry wall shall be provided for the full height of the building for both external and internal walls. Floor-to-floor height shall be minimum 4.25m. A		
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5.02.00 5.02.01	connecting corridor with Main Power House building shall be provided at operating floor level. The floor of the connecting corridor shall have vitrified ceramic tiles, stainless steel hand rail & fixed windows. The connecting corridor shall have double skin metal cladding & insulated metal sheet sloped roof. Hermetically sealed double glazing with toughened glass shall be provided for external glazing. This building shall provide offices for Operation staff, Conference room for 50 persons, C & I Laboratory, Exhibition Hall, VIP Lounge etc. This will be fully air-conditioned building with adequate provision of toilets, pantry, cabins for senior executives and separate rooms for executives, supervisors etc. Lift structure with RCC lift pits shall be located inside the service building. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped on each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms. 2 no's of staircases and 2 no's of lifts with adequate capacity shall be provided. One store room shall be provided The provision for car and scooter parking shall be made. The space for parking facility shall be worked out based on the following method Car parking - 75% of executives' strength housed in Service Building (20 sq.m./car) , Scooter parking- 75% of executives' strength housed in Service Building (5 sq.m./Scooter). Space for visitor's car parking shall also be kept. External finishing shall be of solvent based exterior paint and Coloured Aluminium Composite panel combination Chimney Salient Features One twin flue steel lined reinforced concrete chimney shall be provided catering to the two units of the project. There will be one flue (liner) for each unit. The flue gas emission point shall be minimum 27.5 meters above the plant grade level. The chimney shell (wind shield) shall be constructed using slip form shuttering. Flue liner shall be of structural steel with resin bonded wool type thermal insulation. Internal platforms of steel structure shall be provided for enabling access to various elevations of the chimney and to provide support to the steel liners. Spacing of internal platforms shall not exceed 45.0 M. The platform beams shall be supported on concrete shell using suitable load bearing arrangement in the recesses provided for the purpose. The platform beams getting supported in the chimney shell shall have complete bearing support within the thickness of shell at that location and shall in no case be supported completely/partially on corbels/ brackets from the shell. "Through openings" in shell if provided for supporting platform beams, the same shall be closed with closure wall made of RCC on the external face of the shell. Openings in the concrete shell for flue duct entry, access doors at platform levels, access door & truck entry door at ground level, air ventilation etc shall be provided. Hand railing shall be provided all around the external platforms, internal staircase & around the ventilation voids in the internal platform using min. 32 mm nominal bore MS pipes of medium class conforming to IS:1161 and shall be galvanized as per IS:4736 and finished with suitable paint. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes. All welding shall be done before galvanizing. Spacing of railing posts shall not be more than 1500 mm centre to centre with a minimum height of 1200 mm. The handrail shall have three rows of horizontal members between the railing posts including the top member. Kick plate of min. size 100x6 thick shall be provided in the hand railing. However, for external platform concrete		
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	kerb of min. height 150mm shall be provided all around the periphery. The rectangular flue duct outside the chimney shall be connected to the flue liner inside the chimney through a thermally insulated transition duct. The transition duct shall be bottom supported and shall be profiled into a circular shape to connect to the flue liner. The flue duct shall be so designed that no load is transferred on the chimney shell due to the duct. The interface between the flue liner and the transition ducting shall be provided with non-metallic fluoroelastomeric fabric expansion joint. The expansion joint in the flue liner shall comprise of non-metallic fluoroelastomer material suitable to withstand a temperature of 300°C, shall be acid resisting and shall prevent dust accumulation. The space between the expansion joint material and the liner shall be packed and sealed by providing a bolster made up of light weight compressible material suitable to withstand a temperature of 300°C confined in texturised glass fabric having a final covering of stainless steel wire mesh. External platforms shall be of RCC with pipe handrail. Chimney roof shall be of RCC slab over a grid of structural steel beams and provided with rainwater drainage system. An internal structural steel staircase supported from chimney shell with chequered plate floor panels and pipe handrails, shall be provided for full height of the chimney, internal ladder for a small height, over last staircase landing, to access the chimney roof through a roof access hatch and external ladder over the roof up to the top of flue liner. The inside surface of the chimney shell above roof, horizontal surface of the shell at top, underside of roof slab, top exposed surface of external platforms etc shall be painted with acid & heat resistant black bituminous paint conforming to IS:158 (not less than four coats). Total dry film thickness shall not be less than 150 micron. The entire outside surface of chimney shell shall be painted with alternate bands of signal red and bright white colours, out of which the top 50M of external surface of the chimney shell shall be painted with acid and heat resistant paint, for aviation obstruction day marking, in alternate bands of colours 'signal red' and 'pure/bright white'. This painting system shall comprise of two primer coats of clear epoxy paint (Min DFT of 20 microns per coat. Each coat of this paint, per square metre of the surface, should use at least 0.1 litre) and minimum two finish coats of acrylic polyurethane enamel paint (Min DFT of 35 microns and min WFT of 90 microns per coat. Each coat of this paint, per square metre of the surface, should use at least 0.1 litre). The balance external surface of the chimney shell shall be painted with minimum two coats of synthetic enamel paint (Each coat of this paint, per square metre of the surface, should use at least 0.1 litre), for aviation obstruction day marking, in alternate bands of colours 'signal red' and 'pure/bright white'. The paint shall be applied on properly primed surface with compatible primer. All structural steel works and miscellaneous ferrous components shall be painted/ coated for a maintenance free life of at least ten years as specified under Corrosion Protection Clause unless noted otherwise. Structural steel work in platforms, ladder to roof, strakes, hatches, louvers etc.. shall be painted for high level acid & heat resistant protection with one coat of inorganic zinc silicate primer at 75 microns (DFT) followed by two coats of high build coal tar epoxy paint. Complete staircase assembly and chequered floor panels shall be painted with one coat of chlorinated rubber based zinc phosphate primer followed by one coat of chlorinated rubber based micaceous iron oxide paint and finish painted with two coats of chlorinated rubber based paint. Structural steel embedded in concrete shall be hot dip galvanized as per IS:4736 and finished with suitable paint. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes. The other components of the chimney include liner test ports (for continuous pollution monitoring), liner hatches, grade level slab of RCC with metallic hardener floor finish, a large		
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5.02.02	electrically operated grill type roll-up door at grade level and personnel access metallic doors at grade level and at all platform levels, roof drain basin, rain water down comer pipe (150 mm dia galvanized pipe), connection to plant drains, louvers with bird screens for ventilation and all other openings in the wind shield, galvanized mild steel strake (if required), all finishing works, electrical power distribution boards, lighting panels, power and control cabling and wiring systems, stair and platforms lighting, socket outlet, lightning protection and grounding system, aviation obstruction lighting with photoelectric controller etc, communication system, a rack and pinion elevator and other items, though not specifically mentioned but reasonably implied and necessary to complete the job in all respects. The size of roll-up door shall be determined based on minimum requirement for ventilation and transportation & erection of flue segments. Design Concept Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in Indian Standard, reference shall be made to ACI, BS, CICIND and other international standards. In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail. Imposed loading for design of all chimney components shall not be less than 5 KN/ Sq.m. An additional 25% of liner load shall be taken as impact loading for liner erection in addition to the liner load. The min. thickness of web for plate girders shall be kept as 12 mm. Seismic forces on the chimney system shall be determined based on site specific seismic information provided elsewhere in this document. Wind forces on the chimney system shall be determined based on site specific wind design criteria provided elsewhere in this document. The chimney and its components shall be designed to resist the most onerous forces resulting from all the possible combinations of the various loadings. Design of all chimney components shall be based on working stress method. Wind Shield The wind shield shall be designed for vertical loading, cross wind loading, seismic loading, circumferential wind loading, thermal gradients etc.. The various loading combinations shall be as detailed in IS:4998. The wind shield shall be analysed for cases with and without flue liner loads. Forces/stresses in the wind shield due to eccentricity effects of local (e.g. corbel) loadings, insulations effects, rotation of chimney foundations, construction tolerances and moments of second order shall also be considered. Seismic response of the chimney shall be computed by the response spectrum method. At least, the first five modes of vibrations shall be used for this analysis. The cross wind analysis of the chimney shall be carried out irrespective of the value of the Scruton Number for the chimney and other empirical considerations which suggest structural immunity to cross wind oscillations.		
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	The effect of the openings/cut-outs in the shell wall shall be duly considered in the design of the windshield. The minimum thickness of shell shall not be less than 500mm. The stresses for the shell design shall not exceed the limits given in Cl. 7.0 of IS:4998(PART-I) 1975 for various combinations of loads, excepting the stress in concrete for the case of dead load + wind load which shall not exceed $0.30f_{ck}$ where f_{ck} is the characteristic compressive strength of concrete. The minimum vertical reinforcement shall be 0.3% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 250 mm on each face. The minimum circumferential reinforcement shall be 0.2% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 200 mm on each face. The circumferential reinforcement in the top 3 meters of the windshield shall be twice that required from design forces. The clear cover to reinforcement shall be 50 mm. There shall be a continuous ring of concrete shell without any opening for a height of atleast 5m below the soffit of flue duct openings. There shall not be any reverse (outward) slope in the inside face of chimney shell. Where there is a sudden change in slope/ profile of the shell, the circumferential reinforcement shall be increased to twice the requirement as per the design in a circumferential band extending atleast 3m above and below such slope/profile change level. The diameter of the reinforcing bar for the main vertical reinforcement of shell shall not be less than 25mm for a shell height upto the top level of flue duct opening. Shell thickness between any two 10m reference levels shall not vary more than 150mm. The minimum thickness of shell/closure wall at beam support recess/ opening locations shall be 100mm. Grade of concrete for chimney shell and other super structure shall be minimum M 30. Only OPC cement shall be used for Chimney shell and other super structure. The final design will be checked & verified by 'Wind Tunnel Test' and shall be conducted at a reputed institution. Dynamic interference effects due to additional chimney(s) located in the area or in the future expansion shall be determined along with the other topographical features of the local area through model test. Steel Liners The flue liner shall be made of mild steel. However, the top few meters of the liner shall be so designed and shall be of such material which shall withstand corrosion due to acid attack/condensation of flue gases. The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20-25 metres/second at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 metres/second) to enable adequate dispersion of the flue gases. For the purpose, 100 percent turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60 percent turbine MCR condition with design coal/ worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition. Two manholes placed diametrically opposite shall also be provided in each flue at all platform levels.		
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	The supporting/restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained. The liner thickness shall be determined from structural and corrosion protection considerations. However, the minimum thickness of the liner, determined from structural conditions alone, shall not be less than 6 mm and the corrosion allowance adopted shall not be less than 4mm. Therefore, minimum installed thickness of the mild steel liners shall not be less than 10 mm in any case. Clean-out door shall be provided below the flue for the removal of ash. Internal Platforms The platforms shall be designed for dead, imposed (live), erection work and other possible loadings and temperatures effects. These platforms shall provide support and lateral restraint to the steel liners and provide access for inspections and maintenance. Forces imposed on the floors due to lateral restraint of flues shall be enhanced aptly for impact effects. These platforms shall also be designed suitably for the liner erection works. The platform shall be made up of chequered floor panels supported on grid of structural steel beams. All beams shall have bolted connections. External Platforms External Platforms all around the shell, with a clear walking space of not less than 1000 mm, shall be provided along the chimney height at intervals matching with the levels of the internal platforms. Suitable provisions with steel doors shall be made in the shell for enabling access to the external platform for inspection and maintenance of external surface of the chimney and aviation lights. 32 mm dia nominal bore GI drainage spouts at maximum spacing of 3000mm c/c, shall be provided in external platforms for drainage of rain water. Internal Staircase The staircase shall have a clear passage way width of not less than 800 mm. The riser height shall not be more than 175 mm and tread width shall not be less than 225 mm. Foundation The chimney foundation shall be designed for the most critical combination of forces and moments resulting from all possible combinations of the various loadings from the chimney system during all stages of constructions. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There should be no uplift under any portion of the foundation for any loading condition. Since chimney is a wind sensitive structure no allowance shall be made in the load carrying capacity of the bearing strata / piles under any load case/combination with wind. No allowance shall be made in the stresses for design of foundation for wind loading. The foundation diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12. The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall not be less than 25mm. The spacing of radial steel at the outer edge of the foundation shall not be more than 250mm. Grade of concrete for foundation shall be minimum M 25. Thermal Insulation The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin		
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	bonded rock wool. The coefficient of thermal conductivity of insulation shall not be more than 0.52mW/cm/°C at a mean temperature of 100°C. The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55 degree Celsius. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer-most surface with galvanised wire mesh using MS galvanised pins and speed washer. Electrical System 415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply. Ambient temperature for design of all equipment shall be considered as 55 deg. C which is likely to be encountered inside the chimney. The equipment shall be suitable for installation and render trouble free operation at higher ambient temperature and rigorous weather conditions prevailing at chimney. All equipment supplied shall comply with relevant IS Standards. The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source. Dry type isolating transformer of Dyn connection shall be provided in emergency board to obtain neutral lead, in case 3 phase 3 wire emergency supply is derived from main plant. Various platforms shall be illuminated by dust tight HPSV well glass lighting fixtures. Average illuminations level of 150 lux shall be maintained on equipment and 70 lux on platforms & 100 lux on staircases (minimum 1 lighting fixture at each landing). Any additional fixture to take care of dark patches/shadows shall also be provided. Lighting system shall be controlled through MCB provided in lighting panel. A lighting and power panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 20A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminium wires through galvanised steel conduits. Aviation obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA). The type of aviation obstruction lighting system shall be of high intensity aviation obstruction lights having an effective intensity of 4000 to 2, 00,000 cd depending upon back ground illuminance. Obstacle		
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	lights shall have a day time effective intensity of minimum 200000 cd. The intensity of lights shall reduce automatically to 20000 cd $\pm$ 25% at twilight through the use of photocell and again automatically to a night time intensity of 4000 cd $\pm$ 25% through the use of photo-cell. The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute. A minimum of three levels will be provided with aviation obstruction lights and there will be four light units per level. The lowest level should not be lower than 70 meters above the ground and vertical spacing of the intermediate levels could vary between 70 and 105 meters. Aviation obstruction lighting shall be complete with lights, photo cell, controller, special cables, etc. A temporary aviation obstruction lighting system shall be provided during construction of the chimney. Cables from distribution board to lighting panels/power panels/receptacles shall be 1100V grade, multicore FRLS HR-PVC insulated, PVC inner sheathed,armoured, PVC outer sheathed stranded copper/ aluminium laid on galvanised sheet steel cable trays. Cables shall be terminated using double compression type cable glands and solder less crimping type tinned copper cable lugs. Minimum size of the power cable shall not be less than 2.5 sq.mm copper or 4 sq.mm aluminium. Minimum size of control cable shall not be less than 1.5 sq.mm. Lightning protection system shall comprise minimum 3 vertical air terminations for each flue liner, horizontal air terminations and minimum 4 Nos. of down conductors spaced 90 degrees apart routed all along chimney height on external surface and connected to the earthing system. Down conductors shall be of minimum 50x6 mm galvanized steel strip. Each down conductor shall be provided with a test link at 1 metre above ground level. Each test link shall be enclosed in a galvanised sheet steel enclosure. Above ground level earthing and lightning protection system shall comprise galvanised steel strips. These materials provided at top 12 meters shall have additional coating of 2 mm thick seamless lead cover and the accessories like nuts, bolts, washers etc. shall be of stainless steel to take care of corrosion. Chimney earthing system shall be interconnected to main plant earthing system. A temporary lightning protection & earthing system shall be provided during construction of the chimney till a permanent lightning protection & earthing system is installed. In no case reinforcement bars of Shell should be used as earthing Down Conductors Communication system comprising of telephone socket at every internal platform level and at grade level necessary wiring installation, a telephone hand set, junction boxes etc. shall also be provided. Telephone cables shall be of minimum 0.6 mm dia annealed high conductivity electro copper conductor, PVC insulated, twisted, PVC tape wrapped, screened, rip corded, PVC sheathed, conforming to relevant ITD (Indian Telephones Department) specifications. All equipment to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all type tests as listed below: (A) Distribution boards/panels-Degree of protection tests (B) Aviation lights: (1) Intensity Test (2) Degree of protection test For various equipment, the technical requirements and practices shall conform to the relevant clauses of the main plant electrical specification.			
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	Rack and Pinion Elevator A rack and pinion elevator, with a load carrying capacity of 400 kg (min) (passenger cum goods), cabin floor size of 1100 mm x 1000 mm (min.) and an operating speed of 40 m/min. (approx.), shall be provided for travel from the grade level to the top of the chimney. A landing platform shall be provided at all access/ platform levels. The elevator shall be of a proven and approved make. Enclosure shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high (Approx.). A Safety device comprising of an over speed governor in constant mesh with the rack by means of a flame hardened steel pinion shall be provided to protect the cab against over speed during the cab downward motion and the same shall actuate the brake mechanism and stop the down ward motion gradually. The lift shall be installed using anchor fasteners. The electrical requirement of the system shall conform to the main electrical specification. Drive motor shall be of S3 duty class with CDF of 25% and maximum number of 120 starts per hour in 55 degree Celsius ambient temperature. The motor shall be provided with internal 220V AC single phase space heaters or an alternate heating system. The elevator shall be supplied, installed, painted, tested, commissioned etc. complete with all mandatory spares and operation maintenance manual.			
5.03	Cooling Towers			
5.03.01	Induced Draught Cooling Towers The civil works for cooling towers are related mainly to following areas, but not limited to:			
5.03.01.01	Cooling Tower The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M - 30 grade) as per IS: 456). The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed concrete of grade M-15 as per IS:456 having minimum thickness at edge as 25 mm. Drainage arrangement of basin shall be as specified elsewhere in the Technical Specifications. Galvanized handrail shall be provided all around the cooling tower basin and sludge sump pit. The bottom 500 mm of this railing shall also have galvanized wire mesh with opening size of 50 mm grid to avoid ingress of leaves, vegetation, and debris into the basin. The basin shall be tested for water tightness as per IS:3370. Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for uncracked section as per IS:3370. Hot water duct around cooling towers shall be below ground and encased with min. 500mm thick PCC (M20 grade). <u>Foundation of Cooling Tower</u> The foundation of the Cooling Tower shall be as detailed out elsewhere in the specifications. a) <u>Super Structure of Cooling Tower</u> Columns, beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M-30 (minimum) as per IS : 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.			
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	The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1 : 120 (min.). The slope shall be provided with screed concrete of grade M-15 (minimum) as per IS : 456.. Fan Deck slab and all other over ground platforms shall be provided with galvanised hand rails. Suitable arrangement for drainage of rain water to be provided. However, there is no specific requirement of Rain Water down comers. <u>Cells, Distribution System and Stack</u> Cooling tower cells shall consist of RCC columns, beams and walls. The spacing of columns shall be minimum 4000 mm c/c. Inclined bracings shall not be provided between the columns. Hot water distribution channel shall also be of RCC. Cell division partition walls shall be of precast solid concrete blocks with provision of pilasters for walls, if required. The peripheral wall shall be Cast-in-Situ RCC wall and shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8 mm and maximum spacing as 150 mm c/c. Minimum thickness of Cast-in-Situ RCC peripheral walls shall be 150 mm. Hot water channel shall be covered with suitably designed precast / cast - in - situ concrete slab. Wherever flow control valves are located over hot water basin, these shall be placed over precast concrete covers / concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150 mm. The fanstack shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c. b) <u>Stairs</u> RCC staircase for approach to fan deck for each cooling tower shall be provided. The stairs shall have 1000 mm clear width and GI handrailing. The steps shall be finished with IPS Flooring. The riser shall be maximum 175 mm & treads 250 mm (minimum). Edge protection angle (min 35X35X6, made of aluminum) shall be provided to the treads with the lugs. c) <u>Steel Structures</u> All mild steel parts of structures used in cooling towers shall be hot dip galvanized or sea spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). The minimum coating for galvanization shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of SS 316. d) <u>Water proofing of structures and construction joints</u> For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. In addition Chemical injection treatment shall be provided for the construction joints of all underground structures. e) <u>Expansion Joints</u>		
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	PVC sealing strips shall be used for all expansion joints where water is retained. The minimum thickness of PVC sealing strip will be 6 mm (minimum) and minimum width 225 mm. The expansion joint shall be as per IS: 3370. At expansion joints, joints filler material with sealing compound on both sides shall be provided throughout the length of the joint. f) <u>Grade of concrete</u> All RCC associated with induced draught cooling towers including switchgear and control room, unless specified otherwise, shall be design mix (controlled) concrete of grade M 30 of IS: 456. Water - cement ratio shall not exceed 0.45. Minimum 75 mm thick PCC of grade M-7.5 as per IS: 456 shall be provided as mud mat below foundation unless specified otherwise. The PCC shall extend 75 mm beyond the outer edge of structural concrete. For water retaining structure minimum 100 mm thick PCC of grade M-10 as per IS:456 shall be provided as mud mat below the bottom slab / raft. The PCC shall extend 100 mm beyond the outer edge of the structural concrete. g) <u>Form-Work</u> Plywood Form-work shall be used for basin, basin walls, outlet channel and super structures. h) <u>Doors</u> Single sheet steel door of 18 G mild steel with suitable stiffeners hot dip galvanized or seal spray zinc coated as per IS:5463 (for a very long period of maintenance of more than 20 years) or FRP door shall be provided in each fan stack at fan deck level. Door height & width as per requirement for equipment movement (clear) shall be provided. However, door size shall be minimum 2100 mm high (clear) & 1200 mm wide (clear). The galvanization shall not be less than 610 gm / sq.m as per IS : 4759. Door shall have locking facility. i) <u>Coating</u> All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in Annexure-H. All concrete surfaces subject to water/ water spray/moist air upto and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower) etc shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in Annexure-H. External surfaces of Cooling tower peripheral walls, and fanstack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color. j) <u>Paving</u> Paving shall be provided for a minimum clear width of 5.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher. The minimum total width of paving around CT basin shall be atleast 8.5 m from outer edge of the spray catcher or basin wall. Paving shall consist		
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5.03.01.02	of reinforced concrete base slab laid over 75 mm thick PCC of grade M-10 as per IS:456 sub-base and 200 mm thick stone soling. The sub-base shall be laid on the compacted and suitably prepared sub-grade. The degree of compaction of sub-grade shall be as specified elsewhere in the specification. The thickness of the RCC base slab of grade M - 25 shall be suitably designed considering a superimposed load intensity of 5T / Sq.m. However the minimum thickness of base slab shall be not less than 150 mm having double layered reinforcement in both directions both top and bottom. The maximum spacing of the reinforcement bars shall be 150mm c/c and minimum dia of reinforcement bars shall be 8mm. RCC peripheral drain of minimum cross sectional dimensions 300mm X 300mm to dispose storm water shall be provided around area paving and shall be connected to nearest Owner's storm water drain. k) Walkways Permanent walkways at least 1000mm clear width shall be provided at hot water distribution level and at drift eliminator level for counter flow type cooling towers. The clear working height available above these walkways shall be at least 2.0 meters. The walkway and its supporting structure shall be of RCC M - 30 grade. Suitable RCC guards rails 300 mm high shall also be provided on both sides of these walkways. Over the guards rails hand railing shall be provided. The vertical post of handrail shall be 700 mm high and at an interval of 1500mm c/c. There shall be two levels of horizontal pipes for hand railing spaced equally in vertical plane. Permanent walkways at least 1000 mm clear width shall also be provided for access to fan and around gear box with aluminium gratings with clear opening size not more than 50 MM x 50 mm and grating thickness of 50 mm on RCC supports at fan deck Level. l) Galvanised Handrail Handrail for cooling tower basin, sludge sump pit, fan deck slab, stairs and all other overground platforms shall be made of galvanized 32mm NB medium class pipes conforming to IS:1161 and galvanized as per IS:4763. The vertical posts of handrail shall be 1000 mm high and spacing not more than 1500 mm to c/c. There shall be two horizontal rails one at the top and the other at mid level of vertical post. Galvanised 6mm thick MS plate shall also be provided all along. Rate of galvanization shall be 610gm/sq.m as per relevant Indian Standard.			
	Design Criteria R.C.C. Structures (a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009. These structures shall be designed for following conditions :- 1. Water filled inside upto the designed level and no earth outside. 2. Earth pressure plus 2.0 T / M2 surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside. (b) The design of all structures other than liquid retaining/conveying structures of cooling tower above CW basin slab such as columns, beams, fins, walkways, slabs, cladding/partition wall, fanstack, precast beams etc. shall be carried out by limit state			
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	method as outlined in Clause 4.4 of IS: 3370 (Part 2): 2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3. Wherever, the foundation raft of cooling tower is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the cooling tower foundation is not the same as the CW basin slab and a separate foundation for the cooling tower is provided below the CW basin slab due to founding level requirements, the basin slab shall be designed as a structural slab resting on grid of beams taking support from columns or as a flat slab taking support from columns. Arrangement with providing walls between the columns and the periphery to support the structural basin slab is not permitted. The CW basin slab (both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 and the structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab upto foundation shall be maintained same as the size of the columns just above CW basin slab.. (c) The design of staircase, switchgear building, control room/MD room, transformer and trestle foundation, storm water drain shall be as per IS: 456 (2000). (d) The Cold Water basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370. (e) Fan deck shall also be designed for rolling loads due to movement of equipment during Installation / maintenance operation. Minimum Clear cover for all RCC structures/elements of cooling towers to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000). Fan Supporting Structures <u>Static Analysis & Design</u> The following load conditions and load combinations shall be considered for the design of the Fan supporting structures. (a) Machine Load (b) Load case (a) + unbalance load for the balance of the fan corresponding to G16 as per ISO 1940-1: 2003 (c) Load case (a) + unbalance load corresponding to one blade failure load condition. The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above. <u>Dynamic Analysis</u> (a) Free vibration analysis			
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	A free vibration analysis of the fan supporting structure including the intermediate supporting structure for motor, gear box and pillow block (if applicable) shall be carried out to calculate the natural frequency of the fan supporting structure and its fundamental natural frequency shall be at least + 20% away from the operating speed of the fan and motor. (b) Forced vibration analysis Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition : - - For unbalance load corresponding to G16 as per ISO 1940-1: 2003 - For unbalance load corresponding to one blade failure condition. The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent. Mid Bearing Supporting Structure The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns. Fan Stack The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS : 11504 for Natural Draught Cooling Towers. The fanstack shall have two layers of reinforcement on either surfaces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c. Steel Structure All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanized as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5443 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent. For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as per Cl. 6.04.03. However, for painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting of steel structures as specified elsewhere in the technical specification shall be referred. The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers. Test for water tightness			
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5.03.01.03	The water tightness of C.W. basin, outlet channel, hot water channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS : 3370.			
	LOADING			
	For consideration of loads on structures and load combinations IS : 875 (Part -1 to 5) Code of Practice for design loads (other than Earthquake) for Buildings and Structures shall be followed.			
	Site specific seismic data and wind data shall be followed for design of cooling towers.			
	Live Loads			
	The following live loads (minimum) shall be adopted for the design of buildings and structures associated with Cooling Towers:			
	a)	Roof / Fan deck	500 Kg / Sq. M.	
	b)	RCC Floors	500 Kg / Sq. M.	
	c)	Stair, landings	500 Kg / Sq. M.	
	d)	Chequered & Grating floor	400 Kg / Sq. M.	
e)	Basin, sump and duct	Earth pressure; water pressure as applicable and additional surcharge load of 2.0 T/Sq. M.		
5.03.02	5.03.02.01			
	NATURAL DRAUGHT COOLING TOWER			
	GENERAL DESIGN CRITERIA			
The complete analysis and design of natural draught cooling towers consisting of structural analysis and design shall be carried out by a reputed associate/agency who have carried out the structural design of at least one cooling tower of similar capacity which is in successful operation.				
Loading				
The following loads shall be considered for the design of cooling towers				
Dead Load				
For assessing the self weight of the structure, the specific weight of the concrete shall be taken as 2500 kg/m3. All other dead loads shall be assessed in accordance with relevant codal provision. Dead load shall include the self weight of structure, weight of fill material,				
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	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. Secondary stresses, if any, due to permanent fixtures on the shell shall also be considered. Wind Pressure The wind pressure on the towers shall be assessed on theoretical basis as well as with the help of Model tests in a wind tunnel of turbulent boundary layer. The complete cooling tower shall be designed for all possible wind directions and on the basis of worst load conditions as obtained from Model test and theoretical methods. For conducting Model tests, bidders should survey the whole terrain and make their own assessment of likely critical wind forces & wind-structure interaction. It is pertinent to note that at the project the general topography of the area is uneven with adjacent plant structures of comparable height and a ash mound is present in the vicinity of the plant area. It would be the responsibility of the bidder to collect necessary meteorological data duly vetted from the recognized govt. agencies/ institutions. After collection of necessary meteorological data, most critical wind speed, wind pressure distribution and other necessary parameters shall be determined by the bidder and got vetted by the above agency/appropriate agency(s). Then with the help of physical aeroelastic model tests in a wind tunnel, offering appropriate aerodynamic similitude, the bidder shall obtain the most critical forces, stresses etc. for the cooling tower at various levels and locations. Such model tests shall also include all adjacent topographical features, buildings and other structures which are likely to influence the wind load pattern on the tower significantly including cooling towers for stage-I. The model test shall be carried out in a well reputed institute/testing laboratory after obtaining prior approval from the owner. The testing agency selected by the bidder shall have requisite experience and should have successfully carried out tests in the past for atleast one cooling tower of similar capacity. The model tests shall be duly witnessed and approved by the Engineer. The model test results shall be made available before final approval of the design. All the theoretical methods outlined hereunder for estimating wind loads on cooling tower shell shall be valid only if the towers spaced at clear distance of greater than 0.5 times the base diameter at the finished graded ground level. The theoretical method outlined herein forms the basis only for assessing lowest limit of wind forces and shell structure interaction. Under the theoretical method, the circumferential net - wind-pressure distribution and wind pressure coefficient (p) for the tower shell (without meridional ribs) shall be obtained from the "Criteria for Structural design of Reinforced concrete Natural Draft Cooling Towers" IS: 11504. The above circumferential wind pressure coefficient (p₁) shall be increased by multiplying it by 1.43 to account for turbulence in the incident wind and load intensification due to turbulence induced by the adjacent cooling tower or the other structures of significant dimensions. Therefore, the actual design circumferential net wind pressure coefficient (p) shall be computed as $p=1.43 (p_1)$, where (p₁) is the wind pressure coefficient as per IS: 11504. This design net pressure coefficient (p) and the distribution along the circumference of tower shall be used at all heights of the tower. The above design net pressure coefficient (p) includes the effect of internal suction. In order to compute the quasi-static design wind pressure at a given height along the circumference of the tower, the net design pressure coefficient (p) shall be multiplied by the wind pressure acting at that height [P(z)]. For details, refer, "Criteria for Wind Resistant Design of Structures and Equipments".		
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	The wind pressure at a given height [P(z)] shall be computed as per the stipulations of IS:875. For computing the design wind pressure at a given height the basic wind (V_b) at 10.0 meters height above mean ground level, the risk coefficient K₁, coefficient K₂, Terrain category and class shall be as per "Criteria for Wind Resistant design of Structures and Equipment" as attached elsewhere in the Technical Specification. However, coefficient K₃ shall not be less than one under any circumstances. The wind pressure at a given height shall be computed theoretically in accordance to the IS Codal position given as under: $P_z = 0.6 V_z^2 \quad N/m^2$ The bidder shall also compute the wind pressure (p_z) along the wind direction by Gust Factor (GF) or Gust effective factor method (GEF). Method for estimating the wind load on the tower and other elements, shall be based on IS-875 (part-3)-1987. While calculating the gust factor, the term 'b' shall be taken as the diameter of the throat in Fig. 10 of IS:875 (Part-3)-1987. Design of the tower shall satisfy quasi-static method & GEF method. Dynamic effects on the tower due to wind action shall also be investigated to ascertain the wind induced oscillation such as ovaling and excitation along and across the wind direction. Bidder shall carry out detailed analysis for the tower and consider the worst combination of static and dynamic effects. In case the bidder proposes to adopt aerodynamic rough surface such as provision of meridional ribs in the cooling tower shell, the pressure coefficients as given in the VGB-BTR KUHLTUMRE GERMAN SPECIFICATIONS (latest) (structural design of cooling towers) shall be permitted. The provisions of BTR may be adopted for choosing the value of circumferential wind pressure coefficient (p₁) only. The wind pressure coefficient (p₁), as obtained from BTR after accounting for internal suction, shall be multiplied by a factor 1.43 to arrive at the net design pressure coefficient (p). The bidder shall furnish authorized English Translation of VGB-BTR KUHLTUMRE GERMAN SPECIFICATIONS (latest) for the review of the owner. All other stipulations as specified in these specifications shall be met with. Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented. Earthquake Forces Earthquake forces shall be as per the site specific seismic study result enclosed as "Criteria for Earthquake resistant design of structure and equipments" of this sub-section. The seismic analysis shall be carried out in accordance with IS: 1893 by modal analysis for the hyperbolic cooling towers or any other method as approved by the owner. The earthquake analysis of the shell and its support columns including the foundations shall be carried out by response spectrum method. For the fill supporting structures (RCC frames) response spectrum method is permitted. The modulus of elasticity for concrete shall be obtained from IS:456-2000. All the analysis shall be carried out as per the theory of elasticity. Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented. Loads due to temperature effects The cooling tower shell shall be designed for stress due to axi-symmetric temperature distribution corresponding to external ambient temperature variation from 3 °C to 50 °C.		
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	However, the detailed analysis of actual thermal gradient by considering temperatures inside the tower and external ambient temperatures shall be carried out furnishing detailed references and justification for the same. The shell shall also be checked for thermal stresses arising due to partial operation of the tower in case the operational philosophy so demands. The analysis for the stresses resulting from non-axisymmetric temperature loading shall be carried out. In such non-symmetric temperature loading, the calculation shall be based upon the operating specification. Besides, the shell shall be designed for one sided solar radiation effect also. Nevertheless an effective temperature difference of at least 25 °C across the shell thickness constant over the height and following a sine functions along half the circumference shall be considered. Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented Constructional Loadings The method of construction and the type of formwork to be used shall be decided by the bidder in advance and should be enclosed in the bids submitted. Construction loadings that may occur during execution of work shall be considered in the design of the cooling tower structure. Factors causing temporary loading may include the following depending upon the method of construction. a) Barrowing of concrete b) Scaffolding and formwork c) Loads produced by anchoring devices of climbing scaffolds. d) Hoist fixings e) Storage of materials on scaffolding f) Temporary access f) Tower Crane fixings h) Work temporarily omitted for access purposes. Computations shall be provided to verify the stability of the shell at various levels of construction to ensure that a satisfactory margin of safety always exists during shell construction. Any other load such as foundation settlement All loads likely to act on cooling tower but not specified herein shall also be considered for the design of cooling tower structures. In case different degrees of subsoil stiffness exist, effect of the same shall be taken into account. In such a case, for computing settlements, load distributing capacity of the shell may be considered. Differential settlement between adjacent sections of foundation shall be considered under most unfavorable load combination.		
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5.03.02.02	Load Combinations Following minimum load combinations shall be considered for the design of cooling towers structures A) DL + WL + SL B) DL + Se L C) DL + TL D) DL + WL + TL + SL E) DL + SeL+ TL + SL F) 1.0 DL + 1.5 WL Where DL = Dead Load, WL = Wind load, SL = Settlement Load. SeL = Seismic Load, TL = Thermal Load, In addition to above, construction loads shall be duly accounted for. Under TL various types of thermal loads, as described above, shall be considered separately. Besides above load combination, other load combination as per relevant IS codes shall also be followed.			
	Tower design considerations General The complete cooling tower including the shell, columns, ring beam and foundation, shall be structurally analyzed using a proven finite element modeling technique or an approved alternative method including validation of software used for analysis. For elastic analysis, concrete may be assumed to be un-cracked homogenous and isotropic. The design geometric profile, thickness, variation and support conditions of shell shall be considered in the structural analysis. Regardless of analysis method adopted, the equilibrium checks of internal forces and external loads should be performed. Analysis based on a recognized bending theory of the elastic shells shall be adopted for the design of the tower and supporting structures. Geometric imperfections, if exceed the permissible limit then the analysis of shell shall take into account of such imperfections and resubmitted for owner's approval. Boundary conditions shall be realistic and based on actual configuration. The magnitude of the calculated displacements should be within limits of the applied theory. A detailed dynamic analysis shall be carried out for the complete tower for seismic forces by response spectrum method. The first calculated fundamental natural frequency of NDCT			
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	shall be kept more than 1.0 Hz. Frequency calculation for free vibration analysis shall also be furnished by bidder during detailed engineering. Size and Shape The base diameter air intake opening height, tower height and throat diameter shall be determined by thermal design consideration by the bidder and submitted to Owner for approval. As the range of possible hyperbolic shell shapes is infinite, the same shall generally conform to the following major proportions which have been extensively adopted in cooling tower constructions. $H/D = 1.2$ 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. However, other proven profiles may be permitted subject to approval from the owner. Bidder shall submit along with the offer complete details of the profile, in case the profile is not within the limits stated above, and the names of the sites where such shell profiles have been successfully constructed. Notwithstanding what is stated above, the owner reserves the right to accept / reject the shell profile TOWER SHELL BOUNDARY CONDITIONS A. Shell Analysis and Design The following boundary conditions shall be assumed for the design of cooling tower shell: (a) At upper Edge The top edge of the shell shall be gradually thickened to form a ring beam to guard against possible instability of the top of the shell due to high velocity with gusts. Top edge shall be considered as a free edge in the analysis. The thickness transition from shell to upper ring beam shall be smooth. (b) At Lower Edge The lower edge of the shell shall be thickened to form a lower ring beam. The thickness transition from shell to lower ring beam shall be smooth and shall be considered as an integral part of the shell. The lower boundary of the shell shall be considered as elastically supported by discrete columns. The influence of both support structure flexibility and foundation settlement shall be considered in the analysis and design of cooling tower shell. The shell analysis should include following information at 10 plan angle and of not more than 0.05 of the shell height: a. Meridional and circumferential direct stress resultant and the tangential shear stress resultants.		
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	b. Meridional and circumferential bending moments. c. Displacement normal to the shell mid-surface B. Buckling of Tower Shells Critical dynamic pressure (wind pressure) at buckling shall be as given below: $P_{cr} = \frac{0.07 E_c (d)^{7/3}}{r_{th}}$ P_{cr} = 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 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 as well as whilst under construction. Besides above, a buckling analysis with wind forces should be made using the theoretical tower geometry and boundary conditions, including the influence of dead weight by the method of buckling stress state (BSS) approach in accordance with the provisions of VGB. The buckling safety factor shall be at least 5.0 for load combinations of dead load + wind load. When imperfections in the shell geometry are larger than specified tolerances, the analysis should be rechecked to account for such imperfections and ensure that the desired buckling capacity remains. C. Openings in shells. Opening through the shells should be avoided as far as possible. They should be of smallest required dimensions and shall be shaped such that stress concentration is minimized at the boundary of the opening. Should thickening of the edges be necessary, it shall be smoothly tapered back to the shell thickness. Openings shall be provided with additional edge reinforcement of a minimum cross sectional area at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition, diagonal reinforcement shall be provided at each corner as close as possible. The total cross-sectional area in cm² of this reinforcement shall be 0.5d at each corner where 'd' is the shell thickness in cm. No horizontal thrust due to the inlet piping shall be transmitted to the shell. D. Minimum Thickness of Shell: The minimum thickness of the shell shall be 250 mm		
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	E. Minimum Reinforcement in Shell Spacing and Placement. The Minimum reinforcement to be provided shall be as follows: <table><tr><td>Top one third portion of shell</td><td>0.4% concrete cross-sectional Area along circumferential direction and 0.35% of concrete Cross sectional area along Meridional direction.</td></tr><tr><td>Remaining two-third portion of shell</td><td>0.35% of concrete cross-sectional are in both meridional and circumferential directions</td></tr></table> Minimum bar diameter shall be 8mm in transverse direction and 10mm in meridional direction. Spacing of reinforcing bars should not exceed 200mm in circumferential direction and 250mm in meridional direction. The two layers of reinforcing meshes shall be adequately joined by s-hook over the total shell surface. Atleast two S-hooks in each square metre area of shell surface shall be provided. The hooks shall be of minimum 6mm diameter bars. The concrete cover shall be 50mm minimum. However the clear cover shall not be less than 1.5 dia of bars. The relevant provisions of IS:2210 – criteria for the design of reinforced concrete shell structures and folded plates” and IS:2204 “Code of practice for construction of reinforced concrete shell roof shall also be deemed to be applicable. All other design criteria for the cooling tower shell which are not specified above shall be in accordance with BS:4485:Part 4 and BTR. F. Provision of meridional ribs in Cooling Tower Shell Meridional ribs in the cooling tower shell may be provided subject to the following conditions: a. Thickness of shell excluding ribs shall not be less than 200mm b. Co-efficient 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 else where in these specifications. c. Shell buckling and strength shall be checked as per Clause-B above without considering the effect of ribs. d. All other stipulations as specified in these specifications shall be met with. e. Bidder shall furnish an authorized English translation of the VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (latest) Raker Columns Inclination of the column shall closely match the meridional slope at the shell so that the load transfer to foundation takes place through predominantly axial force in columns. Raker columns shall be designed for the most critical forces transferred to an individual rake column from super-structure considering various load combination. For selecting effective length of the raker columns, following restraints shall be considered.				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 of shell	0.35% of concrete cross-sectional are in both meridional and circumferential directions
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 of shell	0.35% of concrete cross-sectional are in both meridional and circumferential directions							
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	a. In case columns are restrained at both the ends, the effective length shall be 0.8 and 0.6 times the length of the column radially and tangentially respectively. b. In case columns are restrained at one end only the effective length of columns shall be 0.9 and 0.7 times the length of columns radially and tangentially respectively. Fill support structures and Drift Eliminator support structures (if required) The above shall be designed as per the various load combination. Appropriate Live Loads and imposed loads shall also be considered in addition. The design shall conform to limit state method as per IS:456 and 9.10.05 except noted otherwise Pre-stressed Concrete Members Design, construction and workmanship of Prestressed concrete members shall be in accordance with IS:1343 (Latest revision). Steel wire for prestressing shall conform to IS:1785 (Part I) (latest addition) or IS:6003(latest edition). Crack width control shall be limited to 0.1mm. Particular attention shall be paid to achieve an effective bond of the wires in pre-tensioned concrete units. For this purpose, indented wire shall be used. Wire shall be corrosion resistant for the specified duty conditions. R.C.C. Structures a) The design of all liquid retaining/conveying structures of NDCT like C.W. basin, sump, outlet channel, hot water distribution channel/basin, sludge drain and pits shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009. These structures shall be designed for following conditions :- 1. Water filled inside upto the designed level and no earth outside. 2. Earth pressure plus 2.5 T / M² surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside. b) The design of all structures other than liquid retaining/conveying structures of NDCT above CW basin slab such as columns, raker columns, beams, fins, walkways, slabs, partition wall, NDCT shell (all faces) and ring beams, precast beams etc. shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2): 2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3. c) Applicable for CW basin and its foundation only: Wherever, the foundation raft of CW basin of NDCT is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the CW basin foundation is not the same as the CW basin slab and a separate foundation for the CW basin is provided below the CW basin slab due to founding level requirements, the CW basin slab			
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	(both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 and the structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab upto foundation shall be maintained same as the size of the columns just above CW basin slab. d) The design of staircase, switchgear building, control room/RIO room, transformer and trestle foundation, storm water drain shall be designed as per IS: 456 (2000). (e) For uplift due to ground water table the CW basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370. Minimum Clear cover for all RCC structures/elements of NDCT to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000). Steel Structures These structures shall be designed, fabricated and erected as per IS:800 for structural steel work. Stoplog and its lifting arrangement shall be designed for a condition when water in the basin is upto full level and no water outside. Proper rubber seal shall be provided in the stoplog so as to avoid any leakage of water. The material for Stop Log and Trash Rack shall be as specified under Induced Draft Cooling Tower. All mild steel parts or structural steel works used in cooling towers shall be hot dip galvanized with minimum coating of 610gm/sqm. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel SS 316L. a) All welds shall be subject to 100% visual examination. b) Dye penetration test on welds shall be carried out. c) Welding shall be done as per approved procedures and by qualified welders. d) Rubber seal used in stoplogs shall be tested as per the requirements of relevant code. e) Stoplogs shall be checked in dry condition for smooth operation and wet condition for water tightness. f) Galvanising shall be checked/ tested for all tests as per IS:2629. For other detail on steel structures gates etc. refer elsewhere. Test for water tightness The water tightness of C.T. basin, outlet channel, hot water channel, fire water pump house and all other water retaining structures shall be tested as per the provisions of IS:3370. Platforms, Walkways, Stairways, Staircases, Internal Grillage Etc.			
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	They shall be designed as per working stress method IS 456 and IS 800. A minimum live load of 400 kg/sq.m shall be considered for the design of all platforms, Walkways, Staircases, etc. in addition to their own weight. Foundations The design of the tower foundation structures shall be based on IS 456 as per working stress method for worst load combination Foundation shall be checked for safety against overturning, sliding and uplift. While checking stability of the structure, favorably acting loads from water fill, soil cover beyond the edge of the foundation shall be neglected. Water level upto Finished Ground Level shall be considered to take into account buoyancy effect. Net tension should be avoided in the foundations/piles for the shell support foundation. While accounting for over burden of the soil for checking the foundation against up-lift, dead weight of the soil directly above the pile cap or ring raft, as the case may be, shall only be considered, neglecting the weight of soil in the cone of up-lift above the foundation. The foundation structure will be subjected to following loading and extreme load combination case shall be considered in design: 1) Most critical forces transferred from superstructure for the various load combinations. 2) Loading due to foundation settlement 3) Concentrated local loading from column nodes. 4) Thermally induced local loading where hot water ducts pass through the foundation structure without structural isolation. FILL SUPPORT STRUCTURES The self-weight of the fill pack support structure shall be based on the weight of the packing including weight of standing, running and dripping water in accordance with manufacturer's data. Live load of 250 kg/sq.m on the walkways and platforms shall be considered. Hand railings shall be designed for horizontal load of 60 kg/m. Wind deflector walls and any other structural elements shall be designed for a horizontal wind load of 80 kg/sqm. or as per manufacturer's recommendations, whichever is higher. Thermal loading shall be as per manufacturer's recommendations. Earth quake loading shall be considered based on criteria given for cooling tower. Response spectrum analysis shall be carried out. The cold water basin slab/raft shall form the common foundation for the pack support structures. The foundation shall be designed for the most critical forces transferred from CW basin & fill supporting structure including loadings introduced by constructional equipments and crane deployed for fill supporting structure or shell erection. The minimum concrete clear cover to reinforcement in all RCC structures shall be as per IS: 3370, except as mentioned for the following:			
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5.03.02.04	Staircase	30 mm for slab	
	Foundation (for either isolated footing or raft/strip) for all elements.	55mm	
	Columns (below and above ground level)	50mm	
	Fan Stack	40mm	
	The minimum cement content as specified in relevant codal provisions shall be applicable for all structures of cooling towers.		
	CONSTRUCTION MATERIAL		
	The minimum grade of concrete for structural components of cooling towers shall be as follows in accordance with IS:456 :-		
	a) Precast pre-stressed elements	-	M-35 grade
	b) Entire tower shell, columns and basin	-	M-30 grade
	c) PCC encasement (Except levelling course)	-	M-20 grade
d) Mud Mat PCC		M-10 grade	
e) Piles/Tower foundation (with OPC/PPC/PFC)		M-25 grade	
f) All other RCC elements	-	M-30 grade	
The minimum cement content as specified in relevant codal provisions shall be applicable for all structures of cooling towers.			
5.03.02.05	REQUIREMENTS FOR STAGING AND FORMS		
Automatic Clim form scaffolding system shall be used. Slipform with proven record for similar tower may be used subject to specific approval of Owner. The design and detailed construction of the form work and the scaffolding system shall be based on the relevant IS code. In absence of the same, DIN 4420/ACT 347 shall be followed. Realistic loads shall be considered for platforms with regard to the classification of scaffolding system used. For material transport, it shall be designed by accounting for all transportation loads. The connection between individual scaffolding units shall be made in such a way that in case of collapse of one unit, the adjoining units are not affected. Scaffolding system should have atleast two independent safety measures against collapse. Concrete shall have sufficient strength to withstand the anchoring loads of scaffolding system. The concrete strength shall be continuously checked and documented during the climbing process of the scaffolding. Bidder shall prepare at his own cost, detailed scheme, design calculations, detailed working drawings showing all details of form work, staging, scaffolding, member section, connection details and other arrangements for the concreting work and submit the same for approval.			
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	within one (1) month from the award. Only on receipt of the approval by the Engineer the work shall be taken up. However approval of the same by Engineer in no way relieves the Bidder of his responsibility for the proper functioning and safe working of the scaffolding system. Hoisting for Personnel The arrangement and method of raising and lowering of personnel, concrete, reinforcement and other materials to various levels for the cooling tower shell also be got approved from the engineer. Details of equipment and procedure shall be submitted for approval of the Engineer by the Bidder. Any change in the originally approved scheme, design of detailed drawings at a later date shall be adopted only after obtaining the written approval of the Engineer. For shuttering, following provisions shall be complied with: - Self weight of (scaffold + platforms) + minimum superimposed load of 370 kg/m² on total working platform areas at various levels. - Self weight of (scaffold + platforms) + minimum superimposed load of 50% of 370 kg/m² on total working platform area at various levels + earthquake loads. - Self weight of (scaffold + platforms) + superimposed load of 370 kg/m² on total working platform areas at various levels + wind load. For load combination (a) above, no increase in the permissible stresses shall be allowed. For load combinations (b) and (c) above increase of 33.3% in permissible stresses shall be permitted. Design and execution of formwork, stagings, shutterings and scaffolding shall conform to National Safety Council and all relevant IS Code provisions, i.e. IS 2750, IS:4014, IS:4923, IS:800 etc. In case the IS Codes do not cover the specific type of shuttering system, then any International Code of Practice, as approved by the Engineer, may be followed. Notwithstanding the stipulations contained in various codes, safe slenderness ratio shall be determined as follows: - Vertical members: Effective length shall be taken equal to the maximum distance between consecutive horizontal runners in any plane. - Horizontal and diagonal member: Effective length shall be taken equal to centre to centre distance between two nodes If the support from shell for scaffolds are to be taken, following provisions shall be adhered to: - Members connecting/joining scaffolds with shell shall act as propping supports. Use of pre-tensioned or pre-compressed members for propping action shall not be permitted under any circumstances. Connection of propping members with shell shall be designed complying with the above stated requirements. - All prop supports shall be taken at nodal points of scaffolds only.		
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	Splicing joints in vertical pipes shall be such that the joints shall be rigid and the entire cross section area of the pipe takes part in load transference. Special inspection hoist shall be provided by the Contractor for regular inspection. The hoist should be so placed that the inspection, checking of scaffolding members, joints etc. are easily carried out. Regular check at every fortnight of the joints and other elements of scaffolds shall be carried out by the Contractor along with representatives of the Engineer. Detailed inspection record shall be maintained by the Contractor and same shall be produced to the Engineer wherever required. For design of structural members, IS:800 shall be complied with. Notwithstanding the approval from Engineer, the Contractor and his collaborator will be solely responsible for the safety, security, functioning proper functioning and the speed of the construction work. The formwork for shell shall be capable of adjusting to shell profile and thickness accurately, and shall be rigidly braced to prevent deflection or movement during concreting. Forms shall be designed to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. Forms shall be constructed and maintained in proper position and accurate alignment. Accurate alignment shall include maintaining hyperbolic shape, round cross section, and plumbness of concrete shell. Forms shall maintain vertical alignment of form seam marks. Forms for the exterior of the shell shall produce surfaces having a smooth uniform appearance. Forms shall be specially designed and installed so as to prevent leakage of mortar, produce a smooth exterior surface, and permit removal without injury to the adjoining work. The insides of the forms shall be coated with an approved non-staining parting agent that will not impair the blend coatings. The Contractor shall ensure that the parting agent is not applied to the reinforcement. Forms shall not be removed until the concrete has adequately hardened and attained sufficient strength to maintain its shape with no spalling and to support safely its own weight together with any construction loads likely to be imposed. All details of formwork staging, placing, tying etc.; shall be subject to the approval of the Engineer and the Contractor shall submit drawings, when required, showing details of procedure of construction. Contractor shall be responsible for the adequacy of the form work to withstand the pressure of freshly placed concrete or other loads imposed without, movement or deflection of the parts. For concrete surfaces that are exposed to view and for all other concrete surfaces that are to be finished smooth, the lining of forms shall be of smooth non-absorbent lining material. All edges of panels shall be square and straight in both directions and all panels shall match perfectly in length, width and alignment as required. Minimum time of form work shall be approved by the Engineer for RCC shell depending upon weather conditions, quality of cement, etc. Outer ends of the permanently embedded portions of form ties shall be at least 25 mm recessed from the adjacent outer concrete faces.		
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5.03.02.06	All MS embedments shall have anti-corrosive treatment as per Tech. Spec. All temporary construction facilities such as office, warehouse tool room storage shed, casting yard etc. required by the Contractor shall be constructed by the contractor within the area allocated by Engineer at no extra cost to the Owner. Work execution and supervision Bidder shall furnish along with the tender a list of equipments he proposes to deploy in the work. He shall provide and maintain at site all equipments and plants necessary to perform the work. All arrangements for transporting the equipment, material, personnel, <u>etc. to</u> and from the site shall be done by the bidder at his own expense. The owner reserves the right to order from time to time in writing, during the progress of work the removal and proper re-execution of any work which in the opinion of the owner, is not in accordance with the specification in respect of materials and workmanship. During inclement weather the contractor shall suspend concreting for such times as the owner may direct, and shall protect from damages all the works already in progress or completed. All such temporary protective measures shall be at the Contractor's cost. Deployment of a tower crane of appropriate height with a rotating boom of sufficient length capable to deliver the materials such as concrete, reinforcement, etc. regularly and smoothly to the farthest points of the shell at all elevations and plan angles for speedy construction of cooling towers shall be required. Setting out of the shell Survey of absolute position of the shell shall be carried out using the following method: The shell shutters of known radius shall be accurately located through the peg at the base of the tower using a special optical plumb. The optical plumb shall be installed permanently inside of the tower by the bidder. The plumbing of the ring shall be checked at least once per day and shall not be left in the same position for more than four consecutive lifts. The tape used shall be fitted with a spring balance and constant pull of not less than 10 kg shall be applied while reading the tape. No taping shall be undertaken during high wind conditions. Deployment of vertical laser-ray equipment for measuring the dimensions and controlling the shape of the tower at all elevations and plan angles shall be carried out. Measurements shall be taken by vertical laser-ray technique at different points along the circumference of the tower (number of such points shall be approved by the Engineer depending upon the formwork system used) for each lift before placing the concrete and again after concreting. Wherever required adjustments shall be made through spindling of the formwork. The intermediate points between two laser measuring points shall be chord measured i.e. the gauges are measured off a chord taut string. The measurements shall be taken of the inner form work. The outer formwork shall be aligned accordingly. All measuring points on the shell and the chord gauges shall be predetermined by the contractor and got approved by the Engineer. Depending on the number of laser measuring points, a corresponding number of radial lines on the concrete floor shall be provided and reference points shall be marked for the purpose of placing the laser device. The perpendicular shall be checked once in a week or earlier, as required by the Engineer, from outside points.		
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	Tolerances for the cooling tower construction shall be in accordance with the following along with provisions contained in Section VI, Part – E: <table><tr><td>i.</td><td>Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord</td><td>+/- 15 mm</td></tr><tr><td>ii.</td><td>Shell wall centre line in meridional plane measured over a height of 1m</td><td>+/- 10 mm</td></tr><tr><td>iii.</td><td>Shell thickness</td><td>+ 10 mm or- 5 mm</td></tr><tr><td>iv.</td><td>Horizontal radius of shell at any section other than shell base</td><td>+/- 50 mm</td></tr><tr><td>v.</td><td>Horizontal radius at shell base</td><td>+/- 40 mm</td></tr></table> Checking of shell geometry Check for absolute positions may be carried out from ground stations arranged at not more than 10 degree plan angle apart. Readings of horizontal radius shall be taken at every 6 m height or weekly during construction period whichever is more frequent. If the permissible dimensional tolerance are exceeded, the Engineer will instruct the contractor, in writing, to stop construction of the shell. The Contractor shall then examine the situation and submit a report to the Engineer who may require the contractor to demonstrate by calculations that the structural integrity of the shell will not be impaired as a result of the imperfections. The calculations shall be submitted to the Engineer, for approval, before construction will be permitted to proceed. If in the opinion, of the Engineer the calculations show that the integrity of the shell could be threatened, the Contractor will be required to submit to the Engineer detailed arrangement and supporting calculations to set right the shell geometry for approval, before construction will be permitted to Proceed. The cost of carrying out the calculation, any remedial work required and idle time or any delays to the construction programme as a result of dimensional tolerances being exceeded will be borne by the contractor. Adjustment to the tower shell line on the basis of the survey results shall be made gradually, limiting the maximum change of direction from the existing vertical shell profile to be not more than an angular change of 10 mm measured over 1 m of height. Any such adjustment shall be made with full knowledge and consent of the Engineer. The Contractor shall carry out an as-built-survey of each lift of the shell. The results of these checks will be recorded on a suitably developed drawing of the shell from which it will be possible to locate the survey check point. A copy of these results will be presented to the Engineer prior to commencing the next shell pour. The Contractor's shell construction procedures shall include for providing the Engineer with the facilities and a reasonable time period as may be required to carry out an independent check of the completed works.			i.	Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord	+/- 15 mm	ii.	Shell wall centre line in meridional plane measured over a height of 1m	+/- 10 mm	iii.	Shell thickness	+ 10 mm or- 5 mm	iv.	Horizontal radius of shell at any section other than shell base	+/- 50 mm	v.	Horizontal radius at shell base	+/- 40 mm
i.	Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord	+/- 15 mm																
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iii.	Shell thickness	+ 10 mm or- 5 mm																
iv.	Horizontal radius of shell at any section other than shell base	+/- 50 mm																
v.	Horizontal radius at shell base	+/- 40 mm																
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5.03.02.07	Suitable communication system such as telephone, wireless equipments, etc. shall be provided by the contractor so that the communications are possible at different elevations of the tower from the ground during construction. GENERAL REQUIREMENTS (a) (i) In case the basin slab is divided, the same shall be divided into two equal parts by a partition wall designed to withstand full hydrostatic pressure, with one side empty. The basin construction joints shall be made watertight by injection of chemical grout through nipples. The basin construction shall be tested for water tightness, in accordance with IS 3370 (Part-1) (Latest edition). The cost of the test and any rectification and re-test if required is deemed to be included in the Contractor's quoted price. Any cost of filling and emptying of the basin and to rectify defects shall also be borne by the Contractor. (ii) PVC ribbed water stops with central bulb shall be used where expansion joints are envisaged. The minimum thickness of PVC ribbed water stops with central bulb will be 6 mm and minimum width 230 mm. (iii) The basin floor of each compartment shall be provided with a slope of not less than 1 in 120 towards a peripheral drain of minimum width 500mm and minimum depth of 500 mm at the starting point running along the periphery of the cold water basin. Further, this drain shall be sloped 1 in 500 towards collecting sump as also specified elsewhere in the specifications. From sump, the water will be drained by C.I. drain pipe, embedded below the basin floor, into a drain chamber outside the tower basin or as per the arrangements described elsewhere in the tender document. Suitable operating platform with access ladders for operating the gate valve(s) shall be provided in the drain chamber. (iv) A 250 mm high sill shall separate the pond floor from the tower outlet. (v) Uniform surface on the top of basin floor shall be provided. In case undulated surface is observed, a top of layer of minimum 25 mm thick 1:3 mix mortar to be provided to achieve uniform surface. (vi) The level of top of basin wall shall be kept at least 300 mm higher than the top surface of paving outside the cooling tower. (b) The stoplogs and all components of lifting arrangement shall be as specified for Induced Draft cooling towers earlier in the specifications. One set of stop log shall be provided for tower. The rubber seal provided for the stoplogs be tested in accordance with the relevant Indian Standard Code. Stoplogs shall be checked for water tightness and smooth operation in dry and wet conditions. Suitable facilities, as approved by the Owner, shall be provided for handling of stoplogs. (c) A screed or concrete layer not less than 100 mm a thick of concrete grade M10 conforming to IS:456 shall be provided below the cold water basin and other liquid retaining structures. Lean concrete below other foundations and underground structures, unless noted otherwise, shall be of concrete grade M10 (with aggregate of nominal size 40 mm maximum) and shall be at least 75 mm thick.		
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	(d) This specification envisages following anti-corrosive measures for various concrete structures and elements of the Natural Draft Cooling Tower: All concrete surfaces (cast in situ or precast) below and including Drift Eliminator level such as internal surface of CT shell, basin floor, basin walls, spray catcher, sludge sump, all surfaces of raker columns, beams & internal columns, platforms, walkways and any other RCC/PCC components shall receive painting application as per Annexure – (h) to this specification. Suitable primer as per standard practice/manufacturers' recommendation shall be used. The detailed specification of the coating system on concrete surfaces is given in Annexure-(h). (e) Water proofing and plasticizer admixtures conforming to relevant IS Codes may be added as per manufacturer's instruction to the concrete subject to approval of the Owner. (f) All mild steel parts of structures including embedments shall be hot double dip galvanized with minimum coating of 610gm/sqm unless mentioned otherwise in the specifications. Galvanization shall be checked and tested in accordance with IS 2629. All welding shall be done before galvanization. Any site joints required to be carried out after erection shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel SS 316L. (g) i. The tower shall be provided with two numbers external RC Staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height interval unless approved otherwise. The steps shall have a rise of about 175 mm and tread of about 250 mm. Anti - skid nosing at each step shall be provided. ii. Minimum size of all doors shall be 2100 mm high (clear) and 1200 mm wide (clear). The door shall be of FRP material. The door shall be air tight when closed. iii. The hand railing on both sides of the staircase shall be galvanized and shall have rails of 32 mm NB pipes conforming to medium class as per IS: 1239, and posts conforming to medium class as per IS.- 1239 of 32 mm dia galvanized pipes spaced not more than 1.5 M centers. The top hand rail shall be at 1000 mm above the steps. Safety kerbs with 50 mm (minimum) width shall be provided along each edge. Complete hand rails shall be applied with anti-corrosive coating system as specified elsewhere. iv. Minimum coating thickness of galvanization shall be 610 qm/sq.m. (h) Walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. A reinforced concrete platform of 1500 mm clear width shall be provided around the tower periphery which will be a means of access to next walkways and all end valves. Other walkways shall be at least 600 mm wide with 50 mm (minimum) safety kerbs along each edge. Access ways shall be clear of all obstructions such as distribution pipe support beams, drift eliminator support beams, etc. The walkways shall be provided with transverse slots or other opening which will permit the free passage of air and water. Hot double dip galvanized handrails as described above shall be provided on all sides where there is a risk of falling through the fill.			
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	(i) Reinforced concrete platforms 1.2 m clear width all around the tower circumference shall be provided on the tower for fixing of aviation warning light at levels specified elsewhere. Two (2) diametrically opposite MS cage ladders, 600 mm wide, made out of 6 mm x 10 mm flats for full height of the tower shall be provided. Galvanization shall be provided for all MS components. The ladder shall have 20 mm dia rungs at 300 mm centers, with stays at every 2250 mm, connected to the concrete shell and galvanized MS caging consisting of 50 mm x 70 mm vertical cage flats on the exterior surface of each cooling tower upto throat. Above throat level, these ladders shall be continued along the inside surface of the tower upto the top of the tower. The caged ladder shall be provided with intermediate landing of 1000 x 1200 mm wide at every 4500 mm height interval and further, the ladder shall be staggered at each such landing by a horizontal distance of 600 mm to avoid continuous climb. A RCC landing of minimum size 1 m x 1 m with galvanized handrails and galvanized steel door at the throat for interchange shall be provided. Some of the landing levels shall be suitably adjusted to give access to aviation warning beacons for maintenance. Handrails as described above shall be provided on all platforms and landings. The ladder leading to the top platform shall have approach from the ground via the R.C.C. staircase. In order to provide approach for maintenance of shell (inside & outside surfaces), all platforms shall have 20 mm wide radial openings shall be provided in the platform floors at locations, approved by Owner. Adequate numbers of 75 mm internal diameter puddle flanged C.I. pipes shall be embedded in this platform for passing ropes during maintenance of tower shell. (j) Steel gratings, where required, shall be fabricated out of Mild Steel flats with minimum thickness of 6 mm. Thickness of fabricated grating shall be 32 mm with flats so arranged as to have a maximum opening of 25 mm or less. Treads for staircases, where needed, shall be of similar grating construction but provided with toe flats of 6 mm thick, and non-skid taping in an approved manner extending upto 100 mm above the walkway surface. All steel gratings shall galvanized as per specifications. (k) The finished ground level shall be paved for 10.0 Meter width all-round the outer edge of the cold water basin. The paving shall consist of 150 thick RCC slab of M-25 grade. The minimum reinforcement shall be 10 mm dia spaced 150 mm centre to centre both ways top and bottom. The RCC slab shall be overlaid 75 mm thick PCC mat and 300 mm well compacted sand layer. (l) PVC sealing strips shall be used for all expansion and construction joints where water is retained or dry working conditions required. The minimum thickness of PVC sealing strip will be 6mm and minimum width 230mm. The expansion joint shall be as per IS 3370. At expansion joints, joint filter material with polysulphide sealing compound shall be provided throughout the height of the cooling tower. (m) Particular attention must be given to concrete placement because of the thin wall section and the presence of reinforcing steel. Consolidation of concrete shall be by vibration. Removal of air and water at the form surface shall be by vibration and roding. Particular attention shall be paid to accurately shape the corners at all openings. (n) Point of discharge of the concrete in to the forms be 1500 mm above the concrete surface. Concrete shall be deposited in approximately level layers not greater than 400 mm deep unless permitted otherwise. (o) Concrete in the cooling tower shell in each lift shall be so laid that the number of vertical or inclined construction joints are minimized to the extent possible. Horizontal		
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	Design of substructure shall be divided into two parts, namely, (a) Stability analysis, and (b) Structural analysis and design. For the design of substructure, a surcharge load of 2.0 T / Sq.m shall be assumed at the finished ground level for nearby vehicular movement. Stability Analysis The Pump House sub structure shall be analyzed and designed for following load combinations: - 1. Under Operation Stages Maximum load from super structure + equipment load + load from sub structure + no water in the pump chambers + earth pressure at rest from outside with surcharge and maximum ground water pressure. 2. Condition (1) + earthquake/ wind 3. Under Construction Stages No load from super structure and deck slab, load from sub structure with no water in the pump chambers, pump units not installed, earth pressure at rest from sides with surcharge and maximum ground water pressure. 4. Condition (3) + earthquake Following stability checks will be made for the above load combinations: i) Check for overturning Factor of safety against overturning, i.e, the ratio of stabilizing moment to overturning moment shall be as per IS: 456. For the above condition, uplift due to maximum Ground water table (GWT) acting on the base slab and side pressures on the walls due to earth and ground water shall be considered as destabilizing forces. In order to have no tension condition at tip of the base slab, resultant of all the forces acting on the pump house under different conditions of loading as listed above shall fall within middle one third of the base width provided. Maximum compressive stress at other end of the base slab shall be within the safe bearing capacity of soil / rock. Under earthquake condition, resultant of all the forces including earthquake force shall fall within middle three fourth of the base width provided. An increase of 25% shall be allowed in the safe bearing capacity of soil when earthquake forces are considered. ii) Check for Sliding Factor of safety against sliding under static condition, i.e. ratio of horizontal frictional resistance to horizontal sliding force shall be as per IS:456. For this condition, earth pressure at rest and the maximum GWT pressure from sides shall be taken as de - stabilizing forces. Keys shall be provided, if found necessary, to increase the factor of safety against sliding.			
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	To ensure an adequate factor of safety under earthquake condition, the factor of safety against sliding shall not be less than 1.2. iii) Check for Uplift Right from construction to operating stage, minimum factor of safety against uplift due to ground water shall be 1.2. Installation of pressure release valves shall not be permitted in the base slab (raft) of the pump houses to counter the uplift due to ground water. (b) Structural Analysis 1) Base Slab Base slab of the pump houses shall be designed as a raft foundation supported at locations of piers. Following load cases shall be considered: - Maximum water level in the sumps with maximum GWT. - No water in the sumps and maximum GWT. - Alternate bays of sumps filled with water with maximum GWT. - Same as in (iii) above but with minimum water level. 2) Intermediate Piers Intermediate piers shall be designed by working stress method as per IS: 456 (latest), with limiting crack width of 0.2mm for the worst combination of maximum water pressure on one side and no water in the adjacent sump. These shall be designed as RC walls fixed at base and supported (hinged) at top by the deck slab. Since a breast wall may be provided for stop logs and back wall is provided connecting all the piers at the rear end, additional restraints for the pier due to breast walls and back wall may also be accounted for. Intermediate piers are also to be checked for the combined action of direct load due to superstructure and bending due to water pressure from one side. 3) End Piers Design of end piers will be similar to the intermediate piers. The end piers shall be designed for the following conditions: - Soil pressure + maximum GWT + surcharge of 2 Ton / Sq.m. at FGL from outside or design surcharge load at floor level with no water in the sumps. - Only maximum water level in the sump. End piers shall be designed by working stress method as per IS: 456 (latest), with limited crack width of 0.2mm on water face and the outside, i.e., earth side shall be designed as cracked section as per IS : 456. Since end piers are fixed at base and supported (hinged) at top by deck slab, there will be negligible yielding of the wall at top. This will give rise to earth pressure at rest and therefore an earth pressure at rest, $K_0 = (1 - \sin \phi)$ is considered where ϕ =angle of internal friction of soil.		
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5.04.05	End piers shall also be checked for the combined action of direct load due to super structure and bending due to earth pressure with surcharge and ground water pressure. 4) Back Wall Back walls shall be designed as fixed at bottom of the base slab and on two vertical sides by the piers and supported at top by the deck slab. Since back walls are also of the unyielding type, earth pressure at rest, K_0, shall be considered for design. Back walls shall be designed by working stress method as per IS: 456, with crack width limited to 0.2 mm on water face and as cracked section on outer face as cracked section as per IS : 456. Following load combinations shall be considered: i. Soil pressure + maximum GWT + surcharge of 2 T / sq.m. at FGL from outside with no water inside the sump. ii. Only maximum water level inside the sump. 5) Operating Floor Slab Operating floor slab or deck slab shall be designed for loads of the pumps and other equipment, which may be placed on it. A live load of 1.5 ton / Sq.m. shall be considered on the deck slab. The deck / slab shall have monolithic construction with the piers and shall be designed as a continuous RC slab supported on piers. Design of bottom face shall be by working stress method as per IS: 456, with crack width limited to be 0.2 mm. Floor slab of maintenance bay may be designed as slabs on grade. A live load of 3 T / Sq. m. may be considered for the maintenance bay floor slab. Dynamic analysis shall be carried out to ensure proper separation of natural frequency of the structure and pump operating frequency.			
	C.W. Ducts CW ducts from C.W. pump house up to condensers and from condensers up to cooling towers shall run through concrete encased steel lined ducts. The concrete encasement shall be of minimum 500mm thick with square shape outside. M20 grade PCC encasement shall be provided other than locations of duct crossing road, rail or any other facility where RCC encasement of grade M25 shall be provided. Top of CW duct encasement shall be minimum 1.5 m below finished ground level. The minimum thickness of steel pipes shall be as follows including corrosion tolerance of 2 mm: a. For pipes above 1800 mm upto and including 2300 mm dia. - 12 mm b. For pipes above 2300 mm upto and including 3200 mm dia. - 14 mm c. For pipes above 3200 mm upto and including 3750 mm dia. - 16 mm d. For pipes above 3750 mm upto and including 4000 mm dia. - 20 mm			
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	However, for ducts running below rail line/road for a continuous stretch, minimum thickness of CW liner shall be 20 mm. Suitable tap-offs shall be provided in the duct to connect CW blow down, ACW tapping etc. Based on the transient analysis, sufficient number of stub connection shall be provided in the duct to fix air release valves. All duct installation & jointing shall be strictly in accordance with the stipulation given elsewhere in the specification for structural steel work. All the joints of liners shall be butt welded joints. The circular deformation of liner shall be less than 1% of diameter of liner while handling, transportation, erection & construction. If required, temporary bracings may be provided, during handling, transportation & concreting to reduce the deformation. The completed duct shall be tested for water tightness, for the pressure equal to twice the working pressure or 1.5 times the design pressure whichever is higher and shall be generally water tight to Engineer's satisfaction. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld. Any in flow / leakage of water from the duct shall be sealed / repaired at Contractor's cost. However, tests in part of length of duct may be permitted with prior approval only. Wherever required anchor / thrust blocks shall be provided with RCC M25 grade concrete. Suitable RCC chambers shall be provided with precast covers to install flow measurement devices and valves in the duct. Manholes shall be provided in each CW duct at a spacing of 200M (approx.) to facilitate maintenance / dewatering of CW ducts. At least one manhole shall be provided at the deepest point for both intake & discharge duct. Following shall be considered for design of C.W. ducts: a. Maximum design water pressure b. Surge or water hammer pressure of 5.0 Kg / Sq.cm. c. Expected vacuum conditions as arrived from transient analysis d. Soil overburden e. Surcharge Pressure of 2T/SqM Painting as per Cl. 6.04.03 shall be carried out on machined faces, flanges and external exposed surfaces of CW ducts. For external surfaces of CW ducts encased in concrete, painting shall be as specified in Cl. 6.04.02(a).			
5.04.06	CW Channel			
5.04.06.01	The channel shall be of RCC section with vertical wall projecting minimum 300mm above finished ground level. Hand rails with 32 NB (medium) pipe shall be provided on both walls of the channel where height of channel wall is less than 1200 mm above finished ground level.			
5.04.06.02	Each cooling tower (CT) discharge channel shall be designed to carry the required discharge with minimum water level in cooling tower basin and considering minimum value of rugosity coefficient (n) of 0.018 for concrete surface. However, the maximum velocity in CW channel shall be restricted to 1.8m/sec.			
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5.04.06.03	The channel shall be designed by working stress method with crack width limited to 0.2 mm on water face and as cracked section on outer face as per IS: 456 considering (i) no water inside the channel, with earth pressure of soil upto FGL, ground water table upto FGL and surcharge load of 2.0 ton / sq.m from out side, and (ii) with water inside the channel upto maximum level in the forebay / channel and no earth pressure, ground water pressure and surcharge load from outside. The channel shall be checked against uplift due to 50% of the total water head considering ground water table upto FGL. In addition pressure relief valves with under drainage arrangement in the channel shall be provided to prevent uplift of the channel as per relevant IS Codes. Minimum wall thickness shall be 200 mm.			
5.04.06.04	Forebay Structure Forebay consists of retaining wall and forebay slab. The walls shall be analysed as a cantilever retaining wall for stability against overturning and sliding, similar to end piers of the pump house. Pressure relief valves and under drainage arrangements shall be provided below the forebay slab to prevent uplift of the forebay slab. Size and spacing of pressure relief valves shall be designed by the Bidder to take care of the uplift due to ground water table. However, centre to centre spacing of PRV shall not exceed 5000mm. The forebay slab shall be designed against uplift due to 50% of the total water head considering ground water table upto FGL. Minimum thickness of wall at top shall be 200 mm. Hand rails with 32NB (medium) pipe shall be provided on both walls of the forebay.			
5.04.07	Stop-logs and Trash Racks for CWPH & RWPH			
5.04.07.01	Stop-log gates Clear size of the stop logs shall be equal to the clear opening size of water inlet opening below breast wall. Number of segments of the stop log shall be decided to match the capacity of the electrically operated monorail hoist provided to handle it. Structural design of stop log shall conform to IS: 5620 and IS: 4622. Maximum water level for designing the stop logs shall be taken as maximum water level of the forebay. Top and bottom unit of stop log gates shall be designed for their respective water head, whereas the remaining interchangeable units shall be designed for the water head corresponding to the lower most interchangeable unit. The stop logs shall be operated under balanced water head and they are not to be designed for operating under flowing water. Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. These stop logs are used only during maintenance / inspection of pumps. The stop logs shall be operated by means of an electrically operated hoist. Suitable lifting beam shall be provided to operate the stop logs.			
5.04.07.02	Trash Racks Bar screen trash rack is to be provided at inlet of the sump of the pump house in order to prevent ingress of timber & other floating particles which could damage the Pumps. Each bay of pump sump shall be provided with Type - 1 trash rack (removable section rack), conforming to IS: 11388. Centre to centre spacing of trash rack bars shall be 100mm (max). The trash racks shall be provided with number of interchangeable segments, to facilitate easier handling by means of a lifting beam and electrically operated hoist. Trash rack bars shall be designed for a differential water head of 2.0m. and other structural members shall be designed for a differential water head of 1.0m. Minimum thickness of trash rack bars shall be 10mm. Suitable size of horizontal members and end members shall be provided as per design requirements, for efficient operation of trash rack. All trash racks should be capable of being lowered in the associated stop log groove to enable drawal of clean water while a particular trash rack is raised for cleaning purpose.			
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	Suitable arrangement for storing all the stop logs and stand by trash rack shall be provided by the Bidder, to keep them in good working condition.																																															
5.04.07.03	Lifting Beams Separate lifting beams (automatic) shall be designed & fabricated with guide shoes, hooks, links and counter weights etc. complete for automatic operation to engage and disengage the stop logs and trash racks in the required position.																																															
5.04.07.04	Leakage Tests of Stop logs Leakage tests shall be carried out with the stop logs lowered onto the sill. Before observation for leakage, the stop log shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 litres / minute / meter of length of seal under maximum head.																																															
5.04.07.05	Material Specifications of Stop logs & Trash racks All material used in the fabrication of stop log or trash rack shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Bidder, if asked for by the Employer.																																															
5.04.07.06	Materials for the various components of Stop logs																																															
	<table><thead><tr><th>Sl. No.</th><th>Component Parts</th><th>Recommended materials</th><th>Reference</th></tr></thead><tbody><tr><td>1.</td><td>Stop log Leaf</td><td>Structural steel</td><td>IS 2062</td></tr><tr><td>2.</td><td>Stop log Frames, 1st stage embedded parts and structural steel members</td><td>Structural steel</td><td>IS 2062</td></tr><tr><td>3.</td><td>2nd stage embedment</td><td>Stainless steel</td><td>SS316L or IS:1570 (part-5)</td></tr><tr><td>4.</td><td>Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)</td><td>Cast steel</td><td>IS : 1030</td></tr><tr><td>5.</td><td>Wheel axles, wheel track</td><td>Corrosion resistant steel.</td><td>IS 1570</td></tr><tr><td>6.</td><td>Seals</td><td>Rubber</td><td>IS 11855</td></tr><tr><td>7.</td><td>Bearings</td><td>SKF or equivalent</td><td>04Cr19Ni</td></tr><tr><td>8.</td><td>Seal seats</td><td>Stainless steel</td><td>SS316L or IS 1570 (part-5)</td></tr><tr><td>9.</td><td>Lifting pin</td><td>Stainless steel</td><td>SS316L or IS 1570 (part-5)</td></tr><tr><td>10.</td><td>Guide</td><td>Corrosion resistant steel</td><td>IS 6603</td></tr></tbody></table>	Sl. No.	Component Parts	Recommended materials	Reference	1.	Stop log Leaf	Structural steel	IS 2062	2.	Stop log Frames, 1 st stage embedded parts and structural steel members	Structural steel	IS 2062	3.	2nd stage embedment	Stainless steel	SS316L or IS:1570 (part-5)	4.	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)	Cast steel	IS : 1030	5.	Wheel axles, wheel track	Corrosion resistant steel.	IS 1570	6.	Seals	Rubber	IS 11855	7.	Bearings	SKF or equivalent	04Cr19Ni	8.	Seal seats	Stainless steel	SS316L or IS 1570 (part-5)	9.	Lifting pin	Stainless steel	SS316L or IS 1570 (part-5)	10.	Guide	Corrosion resistant steel	IS 6603			
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5.04.07.07	Sl. No.	Component Parts	Recommended materials	Reference	
	11.	Guide shoe	Structural steel	IS 2062	
	Materials for various components of Trash Rack:				
	Sl. No.	Component Parts	Recommended	Reference Materials	
	1.	Trash rack and 1st stage embedded parts	Structural steel	IS 2062	
	2.	2nd stage embedment	Stainless steel	SS 316L or IS 1570 (Part-5)	
	3.	Slide Block	Structural steel with bronze padding	IS 2062 & IS 305	
	4.	Track base	Stainless steel	SS 316L or IS 1570 (Part-5)	
	5.	Track	Stainless steel	SS 316L or IS 1570 (Part-5)	
	6.	Guides	Corrosion resistant steel.	IS 6603	
5.04.07.08	Coating for Stoplog gates and Trash racks shall be as specified in Cl. 6.04.07 "Coating for Mild Steel parts in contact with Water".				
5.04.08.00	Intake Water Pump House and Make-up water facilities upstream Omkareshwar Dam				
5.04.08.01	GENERAL				
	The structures/facilities include intake well, intake water pump house over intake well, approach bridge, area development near river bank including area filling including slope/ reservoir bank protection, switch gear building, control room including battery room, transformer foundations, approach road upto the facilities at river bank from existing road, stop logs, trash racks and various other works including water supply, drains, sewers, disposal of soil etc.				
5.04.08.02	Loading				
	Structures shall be designed for the most critical combinations of loads. For details of loading, refer Cl. No. 6.02.00. In addition, following loads shall be considered:				
	a) Approach Bridge				
	0.5 ton/ Sq.m + Pipes including water load and weight of pedestals + 1.25 times Weight of heaviest component of pump/ motor/ equipment to be moved over the structure at a time				
	b) Water Pressure				
	Water pressure (as per IRC-78) due to maximum mean velocity of current of water shall be				
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5.04.08.03	considered for the design of the intake well and substructure approach bridge/ walkway.			
	Design Concepts			
	The Intake Well & Pump House and Approach Bridge shall be designed with limiting crack width of 0.2mm under limit state of serviceability as per IS: 456. Minimum grade of concrete shall be M-30 as per IS: 456 for Intake water pump house and approach bridge. Durability criteria shall meet the requirements of moderate exposure condition as per IS: 456.However, for intake well steining, sub structure including pier for approach / pipe bridge shall have minimum cover of 50 mm.			
5.04.08.04	Architectural Concepts			
	Intake water pump house over the intake well, switch gear building and control room including battery room shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensive scale, bending tonal values with the surroundings and taking full consideration of the climatic conditions and the building orientation. The pump houses and other buildings shall be architecturally treated in such a way so as to be in harmony with the surroundings. The overall composition may have straight or curvilinear profiles.			
5.04.08.05	Intake Well			
	An intake well shall be founded in the submergence of Omkareshwar Dam on River Narmada at a location indicated in the Tender Drawing. Raw water shall be drawn from the intake well and pumped to reservoir at plant end.			
	The intake well shall be of reinforced cement concrete (RCC) of grade M30. Four (4) openings in well steining shall be provided above the sump slab. The openings shall be provided at two (2) different levels. Generally, the lower openings shall be used to draw water into the pump chamber/ sump. However, during high water level in the river, the lower openings shall be closed using stop logs and water shall be drawn from the opening at higher level. Level and size of the openings shall be such as to draw water into pump chamber/sump with an inlet velocity of 0.3 m/sec (maximum) at all times.			
	All openings shall be provided with trash racks and provision for installing stoplogs. A total of 5 trash racks (4 working + 1 standby) and 4 stoplogs shall be provided for the intake well. Each set of trash rack and stop log may contain one or more number of pieces. The trash racks and stoplogs shall be operated by electrically operated monorail hoist. Steel embedments required for trash racks and stop logs shall be provided for all the openings. An exclusive lifting beam shall be provided to operate the trash racks and stop logs. Stop logs, trash racks, hoists and lifting beams shall be supplied in accordance with specifications given elsewhere in this specification.			
	Depth of foundation of the well shall be decided considering scouring of the river bed and stability of the well. Scouring depth shall be computed in accordance with relevant IRC codes. Termination of the well shall be based on the criteria indicated in Geotechnical Investigation chapter of this specifications and stability of the well considering adequate resistance through passive force below the point of rotation of the well.			
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	Thickness of well steining shall be fixed considering the following: i) Sinking effort and without use of excessive kentledge. ii) The well should be able to resist safely earth pressure developed during a sand blow or during other conditions like sudden drop that may be experienced during sinking. iii) If the well develops tilts and shifts during sinking, it should be possible to rectify the tilts and shifts without damaging the well. iv) Stresses at various levels of the steining should be within permissible limits under all loads and bending moments that may be transferred to the well either during sinking or during service. Cutting edge for the well curb shall be of steel. Depending on construction methodology for the well, a steel caisson may have to be provided. The well may have to be sunk by pneumatic sinking. In the design of well steining, higher of the forces due to open sinking and pneumatic sinking shall be considered. Suitable arrangements required in the well steining to adopt pneumatic sinking shall be provided. Bottom plug with PCC shall be provided after the well has reached its founding level. Sand filling above the bottom plug may be carried out as per requirement. Top plug of concrete shall be provided after sand filling has been carried out upto the design level. Well cap of the sump slab shall be provided over the top plug. The steining of the well shall be raised above the sump slab upto the pump operating floor level. RCC handrail/ parapet wall shall be provided around the operating floor/ platform of well. Intake well (caisson) construction shall include casting of the well on river bank/ shore and then towing to the intake location or it can be in-situ construction also by forming an island. The methodology of the construction shall depend upon the water level and velocity in the river at the time of commencement of construction. If bidder proposes to carry out casting of the well (caisson) on river bank/ shore, he has to make all arrangements like hiring of area etc. at his own cost. Likewise, in case the bidder proposes to use islanding technique, he has to make all arrangements for the same at his own cost, including removal of temporary island. In case casting of the well is carried out on the river/ reservoir bank and towed to its final location, following shall be considered: i) Adequate towing arrangement for towing the caisson shall be provided. The towing arrangement should be such that it will not excessively strain the concrete. ii) Adequate size of flooding valves with long spindles shall be fitted in the outside wall of the well at positions to be approved by the Engineer to facilitate lowering of the intake well. iii) Greatest care shall be taken in towing and placing of well. The contractor shall employ persons fully experienced in this type of towing work. iv) When the well seat has been inspected and approved by the Engineer, the well shall be towed to the site and accurately moored in its final position. Towing plan shall be approved by the concerned authorities. All towing operations of caisson cum well from the river bank/ shore to its final location of placement shall be specifically fully insured against all risks apart from normal insurance of works policy. v) The well shall be sunk by uniformly flooding the well preferably during slack water.		
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	vi) Wells of this height may involve stability problems dependent upon the height of the well constructed prior to the towing into the approximate location for sinking. Prior to the floating of the well, the contractor shall submit his proposed method of operations for the approval of the Engineer. This submission shall be accompanied by detailed stability calculations. Well walls shall be cast to within a tolerance of 5 mm. Sinking of Well Sinking of the well below the river bed shall be executed according to the requirement of IRC 78. The well shall be sunk vertical true to line through all types of soil. The well shall be sunk by excavating material uniformly from inside the dredge hole either manually to the extent amenable and/ or with mechanical equipment. Pneumatic sinking may have to be resorted to by the bidder where obstacles such as large size boulders etc., are met at the bottom or when there is hard strata which cannot be removed by open dredging. The necessity for pneumatic excavation shall be decided by the Engineer. Sinking or loading of the well with kentledge shall commence only after the steining has been cured for at least 48 hours or as specified in the approved drawings. Kentledge or Sinking Load Kentledge shall be placed in an orderly and safe manner such that it does not interfere with the excavation of the material from inside the dredge hole and also does not, in any way damage the steining of the well. Dewatering of Well Dewatering of well shall, normally, not be carried out as a means for sinking the well unless specifically instructed by the Engineer. It shall also never be resorted to, if there is any danger of sand blowing under the well. Water Jetting In situations, when the well is stuck up and normal method of kentledge and dredging fail to sink it further due to frictional resistance being developed on its outer periphery, the frictional resistance shall be reduced by forcing a jet of water all round the well on outer face. Use of Explosives Explosives shall not be used as an aid for well sinking. Precautions during Sinking The dredged material shall not be allowed to accumulate near the well. It shall be dumped from the well as directed by the Engineer. Very deep sump shall not be made below the well curb, as it entails risk of jumping (sudden sinking) of the well. Normally the depth of sump shall not exceed 3.0 metres below the level of the cutting edge unless otherwise specifically permitted by the Engineer. In case the well sinks suddenly and with a jerk, the steining of the well shall be examined to the satisfaction of the Engineer to see that no damage has occurred to it.		
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	Safety Shields Wherever, in the execution of work in which compressed air is used, the working chamber is less than 3.7 metres in length and when such caissons are at any time suspended or hung while work is in progress, in such a way that the bottom of excavation is more than 2.7 metres below the deck of the working chamber, a shield shall be erected therein for the protection of the workmen. Detection of Gases In all cases, where gas is expected including alluvium impregnated with decayed vegetable matter, the use of Davy Safety Lamp in a pneumatic caisson sinking shall be compulsory. Tilts and Shifts Tilts and shifts of the well shall be measured regularly during the entire sinking operation. Observations to this effect shall be taken at each stage of casting of the steining. Simultaneously, as the sinking proceeds, necessary corrective measures shall be taken to contain the tilts and shifts within the permissible limits. Unless otherwise specified, the tilt of the well shall not exceed 1 in 60 and the shift shall not be more than 150 mm. Bedding of Wells Based on the actual rock profile, the cutting edge of well shall be embedded for a suitable depth in the rocky strata. Well sinking through rock upto the required founding level shall be done by suitable means including deployment of divers, chiseling, kentledge etc. In case, dewatering is required, the same shall be adopted as approved by the owner. Additionally, the well shall be nominally anchored to the rocky strata by anchor bars provided in the steining of the well, as an abundant measure of safety, irrespective of development of tension, at the base of the well under design loads. After the well has been evenly seated on good hard rock, arrangements shall be made by the bidder to facilitate proper inspection by the Engineer in dry and visible conditions, before the bottom plug is laid in position. Bottom Plugging Plugging shall only be carried out after the approval of the Engineer after ensuring that the well has been sunk to the final position and there are no cracks anywhere in the steining for its entire length. Concrete for the bottom plug shall be M-25 unless otherwise specified. The quantity of cement shall be increased by 10% for laying concrete under water. Before commencing plugging, all loose material from the bottom of the well shall be removed. Concrete for the plug shall be laid by 'Tremie Pipe' method. Concrete shall be laid evenly inside the well. Least disturbance shall be caused in the water inside the well while laying concrete in the bottom plug.		
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5.04.08.06	Concrete shall be done in one continuous operation till dredge hole is filled upto the required height and thereafter sounding shall be taken to ensure that the concrete has been laid to the required height. Concrete as laid shall not be disturbed in any way for a minimum period of 14 days. In order to check any rise in level of the bottom plug, soundings shall be taken at the close of concreting and for 3 days thereafter once every day. Safety and Design Requirements The design requirements of the pneumatic equipment, safety of personnel and the structure shall comply with the provisions of the Indian Standard IS: 4138. It is desirable that the height of the working chamber in a pneumatic caisson should not be less than 2.5M to provide sufficient headroom when the cutting edge is embedded a short distance below the excavated level and in particular to allow for blowing down. The Contractor shall maintain daily reports on the various activities of well sinking and, in particular, about the safety of the personnel working in the working chamber below the river bed under high air-pressure. The reports shall be submitted to the Engineer every day at a suitable time decided by the Engineer.			
	Rock Anchor (1) Rock Anchor is an untensioned reinforcing element consisting of a rod embedded in a cement grout filled hole. The rock anchor shall have a plate and a nut. (2) Rock anchors shall be of Min. 32 mm dia. and shall be of various lengths as per design requirement (for longer lengths, couplers may be required). (3)The Rock anchors shall be manufactured from reinforcing bar with Yield strength not less than 500 N/mm2. (The reinforcing bar shall comply with IS 1786.) When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125 % of the yield load of the bar. (4) Rock anchors shall be furnished complete with all accessories and other materials necessary for their installation, fixing and grouting. (5) Bearing plates shall be flat or dished steel plates of following minimum dimensions: 32mm dia. rock anchor - 1 no. plate of 200x200x12mm The plate shall conform to IS 2062 for Structural Steel. The nuts shall be heavy hexagonal type. (6) The threads on the projecting ends of anchors shall be protected and lubricated with rust preventive compound. (7) The surface of the rock anchors shall be clean of rust, scale, dirt or other foreign matter. (8) Minimum diameter of hole drilled for installation of rock anchor shall be 1.5 times diameter of Rock anchor. (9) Spacers (centralizer) shall be used for 32 mm dia. rock anchors longer than 4m for equal grout annulus all around the bolt. (10) The length of drill hole shall be such as to receive the specified rock anchor and to provide for its satisfactory anchorage, and sufficient provision of the threaded portion out			
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	of hole to fix plate, nut, and coupling for any kind of extension piece. The holes shall extend 150 to 200 mm beyond the length of the rock anchor. (11) After drilling each hole in sound rock, the drill hole shall be washed with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tends to swell or is interspersed with clay filled fissures, shall be cleaned with compressed air only. The compressed air shall not contain oil or any other material which could prevent the bond between rock and grout. (12) Prior to installing the rock anchor, the rock surface around the hole shall be prepared for the bearing plate. When the surface is not perpendicular to the hole axis, beveled washer shall be placed between the bearing plate and the nut, or dished bearing plate and hemispherical washer used, to ensure uniform bearing. (13) Both for overhead application and horizontal (slightly downward) application, the grout shall be introduced into the end of the hole through a pipe. The pipe will be gradually withdrawn as the hole is filled. (14) Grout shall have a low water to cement ratio. An admixture containing an efficient water reducing agent, a shrinkage compensating component shall be used. The grout mix constituting 1:1 cement / sand mix shall be used. Doses of the admixture shall be as per the manufacturer's recommendation to achieve the required properties. (15) The anchor bar shall be forced into the grout-filled hole before the initial set of the grout and good contact between steel surface and grout ensured. (16) Anchors bars shall be protected after installations in such a manner as to prevent any movement until the grout has hardened. Any bars found to be loose after the grout has set shall be replaced. TESTING AND MONITORING OF ROCK ANCHOR (i) The Contractor shall furnish atleast two sets of testing equipment including hydraulic jacks, fixing device, hydraulic pump with pressure gauge/manometer, extensometer and all necessary accessories. The testing equipment shall be capable of stressing the largest diameter rock bolt to the yield stress of the bolt. (ii) Prior to the installation of rockbolts in the works, a series of pull-out test shall be carried out in different rock types, and which will be representative of the rock expected to be encountered during the excavation, to prove the suitability of the rock bolts. During the pullout test, both the load applied and movement undergone shall be measured. Atleast five tests shall be required for each combination of rock type / installation condition/bolt type to be able to asses the capacity of the rockbolts/ rock anchors. The initial pullout test shall be carried out up to the failure (yield load). The capacity (safe load) of the rock bolt shall be ascertained with a factor of safety 2.5 and on average failure (yield) load for each combination. Rock bolts failed before reaching yield point due to improper workmanship or defect in material shall be rejected. The pull-out test shall be carried out sufficiently in advance of the installation of the rock bolts in the works so that, in the event that the proposed rock bolts do not meet load-strain requirements, the Contractor shall have time to furnish the tests for rockbolts of a different type. (iii) During progress of the work, the contractor shall perform routine pullout tests, on at least 5% rock bolts installed or part there of in each strata. Routine pullout test shall be carried out for safe load for the rock bolts as desired above or 3 Tonnes per one metre length of the bolt which ever is maximum. As the pulling load increase step by step, deformation of the anchor plates shall be recorded for safety. Rock bolts which fail under the routine pullout test shall be reinstalled at other locations. The		
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	Contractor shall maintain detailed records of the pullout test, the result of which will be used to establish relationships between rock quality and type of rockbolts and tensioning. If the results of the pulling load test are not satisfactory, installation of additional rock bolts can be made to compensate for the reduction in capacity of the installed bolts. In case of failure, additional testing shall be performed on selected rock bolts installed in the vicinity of the failed one and the rock bolts shall be replaced. If large scale failure is reported, the effectiveness of whole lot of bolts installed shall be decided by Engineer in charge. (iv) If any rock bolts fails due to improper workmanship or defect in materials or due to any reason whatsoever, the Engineer in charge may order a test on all adjacent rockbolts and all rockbolts so failing shall be rejected, replaced and retested by the contractor at no extra cost. (v) The bolts and anchors shall be checked for their straightness Tolerance with + 1 mm. The pullout trials shall be conducted in conformity with IS: 11309.		
5.04.08.07	Dredging in River/reservoir After completion of construction of intake well, if bed level in vicinity and around the intake well is higher than the invert of water inlet opening and is not able to draw adequate quantum of water into the well, the river bed shall be dredged for sufficient width, depth and length from deep water channel of the river extending from upstream of the intake well to downstream of the intake well so that adequate water flows smoothly into the intake well sump. The dredged material shall be disposed off as directed by the Engineer.		
5.04.08.08	Intake Water Pump House The intake water pump house over the intake well shall be of RCC construction upto crane girder level/ bracket level. Above crane girder level/ bracket level, structural steel super structure with troughed permanently colour coated sheet metal cladding shall be provided on exterior face. The sheet metal cladding shall be provided with adequate overlap.		
5.04.08.09	Approach Bridge Approach bridge shall connect the intake water pump house over the intake well to the river/reservoir bank. For the length of the bridge, refer Tender Drawing. Exact length shall be based on final location of Intake well. The deck of approach bridge shall be sized for make-up water pipelines, electrical cabling and space for movement of equipment required in the pump house. The deck shall be of structural steel. Hand rail for the structure shall be provided. The deck shall be supported on longitudinal beams and cross beams. Bottom of girder including deck shall be above the HFL with adequate clearance as per relevant IRC codes. The top level of the deck shall be equal to the top level of operating floor of the intake water pump house. The entire deck shall be supported on piles/piers. The deck slab shall be designed for the live loads, pipe loads including water & weight of pedestals and 1.25 times load of heaviest equipment to be moved over the approach bridge. Apart from the specified loads, any other equipment or possible overloading during construction/ erection/ installation of pipe line/ equipment and maintenance shall also be considered in the design.		
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5.04.08.10	The critical deflection shall be limited such that it shall not produce difficulties in serviceability conditions nor shall it cause damage to the structures and pipelines supported on the bridge, and its components etc. The horizontal deflection shall be checked for wind/ earthquake and current loading and the maximum value shall be limited to L/350, where “L” is the average distance between bridge support points. The bridge shall be designed to accommodate transverse and longitudinal differential movement between supports. Predicted maximum relative deflection shall be calculated based on “Worst case” situation, i.e., the sum of the maximum absolute deflections of the adjacent segments/ platforms. One end of the bridge shall be designed as hinged support and the other end as a sliding support. The sliding support shall provide guide restraints in the vertical and lateral support. The sliding support shall be a self-lubricating bearing element. 150% of the total predicted translation shall be allowed for the end connection and bridge design. The hinged connection shall be designed to withstand 150% of the expected axial thrust. Bridge support shall be capable of accommodating a tolerance in all directions for final support location. The tolerance shall be determined based on the accuracy of construction of support.																																				
	Data for Design of Intake Well and Approach Bridge The proposed location of Intake Well is approximately 1200M upstream of Omkareshwar Dam on river Narmada. The salient features of the Reservoir/Dam are as collected are as follows: <table><tr><td>(a) Top Level of Dam</td><td>: 203 M</td></tr><tr><td>(b) Maximum Water Level</td><td>: 199.62 M</td></tr><tr><td>(c) Full Reservoir Level</td><td>: 196.60 M</td></tr><tr><td>(d) Minimum Draw down level</td><td>: 193.54 M</td></tr><tr><td>(e) Actual water level (on 13.05.2011)</td><td>: 188.5 M</td></tr><tr><td>(f) Gross Storage</td><td>: 0.987 Bm³</td></tr><tr><td>(g) Live Storage</td><td>: 0.299 Bm³</td></tr><tr><td>(h) Dead Storage</td><td>: 0.688 Bm³</td></tr><tr><td>(i) Length Of Dam</td><td>: 949 M</td></tr><tr><td>(j) Height of Dam</td><td>: 53 M</td></tr><tr><td>(k) Stilling Basin</td><td>: 55 M</td></tr><tr><td>(l) Gates</td><td>: 23 Nos. 20M Wide and 18M High</td></tr><tr><td>(m) Maximum Head</td><td>: 34.40 M</td></tr><tr><td>(n) Minimum Head</td><td>: 30.78 M</td></tr><tr><td>(o) Designed Head</td><td>: 32 M</td></tr><tr><td>(p) Designed Discharge</td><td>: 237.25 CuM</td></tr><tr><td>(q) Penstock</td><td>: 8 Nos. 7.66M Diameter</td></tr></table> For details of hydrographic survey near proposed Intake Location on upstream of Omkareshwar Dam on river Narmada, refer Tender Drawing No. 9878-001-PVC-A-003. Any other data required for design of Intake Well shall be arranged by the Contractor.				(a) Top Level of Dam	: 203 M	(b) Maximum Water Level	: 199.62 M	(c) Full Reservoir Level	: 196.60 M	(d) Minimum Draw down level	: 193.54 M	(e) Actual water level (on 13.05.2011)	: 188.5 M	(f) Gross Storage	: 0.987 Bm ³	(g) Live Storage	: 0.299 Bm ³	(h) Dead Storage	: 0.688 Bm ³	(i) Length Of Dam	: 949 M	(j) Height of Dam	: 53 M	(k) Stilling Basin	: 55 M	(l) Gates	: 23 Nos. 20M Wide and 18M High	(m) Maximum Head	: 34.40 M	(n) Minimum Head	: 30.78 M	(o) Designed Head	: 32 M	(p) Designed Discharge	: 237.25 CuM	(q) Penstock
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5.04.08.11	Model Study for Intake Well Dimensions of pump chamber/ sump in the intake well shall be fixed up initially based on Hydraulic Institute Standard. The dimensions shall be confirmed by conducting a Hydraulic Model Study at a recognised Institute/ hydraulic research laboratory. Scale of the model shall be 1:10. The hydraulic model study shall be conducted to study water level in the pump sump, flow conditions in the pump sump for different discharges & different depths of water, different combinations of pump operations to study velocity distribution in pump bays, etc. The model shall be based on Froude's law of similitude and shall also be tested for following two more flow conditions, viz. a. At twice the prototype maximum Froude number, i.e., the Froude number of the model is two times that of the prototype. b. At equal velocity criterion, i.e., the velocity is same both in the model and prototype. The final recommendation shall be based on 2F condition. Based on recommendations of the hydraulic model study, necessary modifications shall be made in the pump sump, dimensions of water inlet openings, additional structural features required such as flow straighteners, baffle walls, mesh screens, grid walls, guide vanes, floor splitters, anti - swirl cone etc. for elimination of non - uniform velocity distribution, swirls and vortices in the model etc. The physical model shall be replica of proto-type and consists of part of river/reservoir with an intake well and pump house along with openings.			
5.04.08.12	Area Development for Make-up water facilities on the River/ Reservoir Bank Cutting/ filling is required to be carried out within the land acquisition boundary (100M x 75M) on the river/reservoir bank u/s of Omkareshwar dam for make-up water facilities including switchgear room, control room, transformer foundations, 66kV substation etc. for feeding power supply to the Intake water pump house. The FGL of the area shall be 2M above maximum water level of the dam. Material for area filling, details of compaction and slope protection shall be as specified at Cl. No. 4.03.00 for site leveling and slope protection works.			
5.04.08.13	Bank Protection Bank protection shall be carried out along the bank of reservoir for the length of the land acquired for Make-up water facilities. The reservoir bank protection shall consist of min 300thk stone rip-rap with jointing and pointing in cement mortar of grade 1:6.			
5.05	~~DM Plant, PT Plant, ETP, CW Chemical Treatment and CPU Civil Works~~			
5.05.01	Design Concepts for Buildings/ Shed i.All buildings shall have framed super structure ii.Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and side open. However, korb wall shall be provided all around the plinth/ floor area above the			
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	Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided. iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.			
5.05.01.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.			
5.05.01.02	The load and load combinations and design criteria shall be as specified elsewhere in the specification.			
5.05.01.03	All liquid retaining structures shall be designed for following load conditions. Underground structures: a. Water filled inside up to design level and no earth outside. b. Earth pressure with surcharge of 2.0 T/m² and ground water table up to FGL outside and no water inside. c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.25 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure. d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table. For design of over - ground liquid retaining structures appropriate load cases shall be considered.			
5.05.01.04	All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2):2009.			
5.05.01.05	In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.			
5.05.01.06	Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.			
5.05.01.07	Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.			
5.05.01.08	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.			
5.05.01.09	The minimum grade of concrete for all RCC structures associated with DM plant, PT plant, ETP, CW chemical treatment and CPU shall be of grade M30. The minimum concrete clear			
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	cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to moderate exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.																		
5.05.01.10	Factor of safety against overturning and sliding The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.																		
5.05.01.11	For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.																		
5.05.01.12	Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.																		
5.05.01.13	Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows:																		
	<table border="1"> <thead> <tr> <th>Sl. No.</th><th>Structural Element</th><th>Main Reinforcement</th><th>Distribution Reinforcement / Stirrups/ ties/ Anchor Bars</th></tr> </thead> <tbody> <tr> <td>a)</td><td>Foundation</td><td>12 mm</td><td>12 mm</td></tr> <tr> <td>b)</td><td>Beams</td><td>12 mm</td><td>8 mm</td></tr> <tr> <td>c)</td><td>Columns</td><td>12 mm</td><td>8mm</td></tr> </tbody> </table>	Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars	a)	Foundation	12 mm	12 mm	b)	Beams	12 mm	8 mm	c)	Columns	12 mm	8mm		
Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars																
a)	Foundation	12 mm	12 mm																
b)	Beams	12 mm	8 mm																
c)	Columns	12 mm	8mm																
5.05.01.14	Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.																		
5.05.01.15	Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.																		
5.05.01.16	Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.																		
5.05.01.17	Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.																		
5.05.01.18	Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.																		
5.05.01.19	Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.																		
5.05.01.20	All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere.																		
5.05.01.21	All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.																		
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5.05.01.22	2.0m wide walkway with concrete paving shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL.			
5.05.01.23	Architectural Concepts and Finishing Schedule Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.			
5.05.02	Acid / Alkali Resistant Treatment: Acid / alkali resistant lining treatment shall be provided in different areas as follows: Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick A.R. bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification. The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R. bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted. The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron). Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby. Alum/Lime Storage area and first floor of Chemical House : One coat of bitumen primer followed by 12mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick underbed of potassium silicate mortar, 6mm thick pointing of joints of tiles with acid /alkali resistant epoxy /furane mortar up to a depth of 20 mm and bitumastic end sealing. Alum solution preparation tank: The wall shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 75 mm thick A.R. tiles, 6 mm thick underbed by potassium silicate mortar, pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer. Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer. Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks. Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the			
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	pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns. Lime tank: Two coats of bitumen paint conforming to IS : 9862, with total DFT 150 microns. Guarantee The Contractor shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.			
5.05.03	DM Tank Foundation			
5.05.03.01	General Requirements			
	The tank foundation shall be as per IS:803 and as specified in Cl. No.7.01.04.			
5.05.03.02	Sub Grade Preparation			
	The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).			
5.05.03.03	Anti Corrosive Layer			
	Anti-corrosive layer shall consist of screened coarse sand, mixed with 80/100 bitumen or equivalent 8% to 10% by volume.			
	Bitumen shall be heated to a temperature 175 ^o C to 190 ^o C, with 3% kerosene, if required. Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.			
	The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.			
	Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.			
5.05.03.04	Premix			
	Materials			
	Sand			
	Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).			
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5.06 5.06.01	Stone Chippings Stone chippings shall be hard black trap or granite or approved locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.				
	Bitumen Bitumen required for the work shall be 80/100 grade or its equivalent quality.				
	Laying Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed. The Binder bitumen 80/100 shall be heated to the temperature of about 190° C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.				
	Switchyard Civil Works				
	Civil works for switchyard includes:				
	a. Towers, girders, lightning masts and equipment supporting structures including proto type assembly etc.,				
	b. Foundations and supporting pedestals for towers, lightning masts, equipment supporting structures etc.,				
	c. GIS/Control room/Auxiliary building as required for switchyard, foundation for AC Kiosks etc.				
	d. Foundations for transformers and reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers / reactors, rail track, jacking pad and fire walls as required, arrangement for cabling etc. all complete				
	e. Earthing mat, single lane roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,				
5.06.02	f. All necessary embedments, inserts, supporting structures & supporting members as required etc.				
	g. Cable trenches in switchyard and inside GIS/Control room/Auxiliary building including civil works for panel fixing etc.				
5.06.02.01	Design Criteria Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to IS 2062 and duly galvanized conforming to IS: 2629 and IS 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS 12427 and of property class 5.6 as per IS 1367 (Part 3). Nuts shall conform				
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5.06.02.02	to IS 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS 5624 and property class shall be 4.6 as per IS 1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS 802 "Code of practice for use of structural steel in overhead transmission line towers" shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose. The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc. Switchyard structures shall be designed for the worst combination following loads: 1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members), 2) Live loads, 3) Wind loads a. Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS 802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (V_b) and terrain category as stipulated in "Criteria for wind resistant design of structures and equipment". b. All other structures shall be designed as per IS 456 / IS 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in "Criteria for wind resistant design of structures and equipment". 4) Seismic loads, 5) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in horizontal plane and ± 20 degree deviation in vertical plane), 6) Loads due to unbalanced tension in conductor/wire, 7) Torsional load due to unbalanced vertical and horizontal forces, 8) Erection loads, 9) Short circuit forces including snap in case of bundled conductors, etc. Note: i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space. ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting		
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	perpendicular and parallel to bus conductor and shield wire shall be considered separately. iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries. v. The distance between terminal and dead end gantry shall be taken as 200 meters.			
5.06.02.03	Factor of safety: The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition. Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition.			
5.06.02.04	Design consideration for switchyard equipment support: The supporting structure for B.P.I., LA, CVT & Isolator equipments shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1151 & shall be designed as per IS 806 "Code of Practice for use of steel tubes in general building construction". Minimum diameter of the pipe type support for 765kV structure shall be 300NB, 400kV structure shall be 250NB, for 220kV & 132kV structures shall be 200NB and that for 66kV & 33kV shall be 150 NB. The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802. Common raft foundation shall be provided for each pole of isolator.			
5.06.02.05	Special design consideration for lightning Mast: Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m² above platforms shall be considered for design of Lightning Mast.			
5.06.02.06	Design Criteria for structures not covered under Cl. 5.06.02.01 to Cl. 5.06.02.05 The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of rooms/facilities/ equipment/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes. The design of RCC structures shall generally be carried out using limit state method of design as per IS 456. The minimum grade of concrete shall be of RCC M25 as per IS 456.			
5.06.03	The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.			
5.06.04	The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS 802 and IS 800. All materials shall be completely shop fabricated and galvanised.			
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5.06.05	All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Minimum section thickness should not be less than 4 mm. Weight of zinc coating shall be at least 0.610 kg/m2 and foundation bolts shall have heavier zinc coating at least 0.80 kg/m2.			
5.06.06	Cable Trenches Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o/p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.			
5.06.07	Stone Filling: Stone filling shall be provided as specified elsewhere in the specifications. Each layer shall be compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling. Before laying the stone fill, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed/soil sterilization chemical shall be procured from reputed manufacturer. The Bidder shall submit necessary details pertaining to the types of weeds found in the vicinity, anti-weed/soil sterilization such as manufacturer's name, their specification, test certificate, etc., for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the Bidder at no extra cost to the Employer. The Bidder shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.			
5.06.08	Transformer/reactor foundations Foundations of transformers/reactors shall be designed for seismic and wind loads. Block foundations shall be provided for the main transformer block. The oil soak pit, if provided, shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store complete oil of the transformer/reactor along with 10 minutes of fire water considering only 40% of the volume as available voids between Stone-filling. However, in case a separate oil collection tank is provided for the transformer/reactor, oil soak pit of volume equivalent to one-third (1/3) the oil volume of transformer/reactor shall be provided around transformer/reactor. The oil collection tank, in such cases, shall be designed for an effective capacity of complete oil of the transformer along with 10 minutes of fire water. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit. Arrangement for moving the transformer into place using rail cum road, jacking pads and			
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	pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations. RCC Firewall shall also be provided between the transformers wherever required. 300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of Stone filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.			
5.06.09	The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.			
5.07.00	COAL HANDLING PLANT It includes the Civil, Structural and Architectural works related mainly to the following areas (but not limited to):			
5.07.01	Wagon Tiplers, Reclaim Hopper, Underground TP's & Tunnel Wagon tipplers, Underground portion of TP's and Underground Tunnel shall be of R. C. C. Shed shall be provided over Wagon tipplers. The vertical and inclined portion of coal hopper and beams in reclaim hoppers shall be provided with 50 mm thick guniting (shotcreting). Details of shotcreting have been given elsewhere in this specification. Expansion joints shall be provided at a maximum distance of 40m unless otherwise shown in the tender drawing. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polyurethane sealing compound as specified elsewhere shall be used as expansion joint material. Detailing of expansion joints shall be as per details in the tender drawing. Construction joints shall also be provided with 600mm wide water stop 22G copper plate. Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m². Water proofing / Damp proofing of underground portion of Wagon tippler, reclaim hoppers, tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments: a. Chemical injection grouting for inner faces (details as specified elsewhere). b. Polymer modified cementitious coating on earth side face as per the following : (1.) On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and			
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5.07.02	as per manufacturer's specifications shall be provided directly on the concrete surface. (2.) 50 mm thick P. C. C. (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 mm thick P. C. C. (1 : 2 : 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft. Steel gratings of mesh size 350 mm x 320 mm for wagon tippler hopper shall be provided. The grating shall be built of min. 200mm x 28mm thick flats in main direction and min. 100mm x 20mm thick in secondary direction. The hopper and gratings shall be designed for movement of front end loader/ bulldozer over them. Bull-dozer weight shall be considered as about 35T. No painting/galvanization shall be provided in gratings. However, two coats of Red oxide Primer to be provided immediately after fabrication. Earth pressure to be considered for design shall be due to earth pressure at rest (K_0) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (U. D. L) of intensity $2 T / \text{Sq. M.}$ whichever is critical, shall be considered in the design. A minimum safety factor of 1.2 against uplift of wagon tippler, transfer points (underground or with basement) and tunnels, due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees. Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any, in the vertical plane. Inclined wedge action of soil shall not be considered in this case. Wherever, slope of tunnel exceeds 10°, R. C. C. steps shall be provided for the entire width of each walkway. Overhead / Ground Conveyor Galleries and Trestles Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Seal plates under the conveyor galleries shall be provided in such a way that complete		
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	gallery bottom shall form a leak proof floor. The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors. For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery (except tripper conveyor) shall be 800 mm and 1100 mm respectively. For tripper conveyor, the width of walkways shall be as per functional requirement. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10°, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere. Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification. Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location. For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided. For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc. Thus coal load per unit length of each moving conveyor shall be <table><tr><td></td><td></td><td>Rated Capacity of Conveyor system</td><td>1100</td></tr><tr><td>1.6</td><td>X</td><td>-----</td><td>X -----</td></tr><tr><td></td><td></td><td>Conveyor Belt Speed</td><td>800</td></tr></table> It should be noted that for structural design, unit weight of coal shall be assumed as 1100 Kgs. / Cu. M. instead of 800 Kgs. / Cu. M. considered for system sizing purpose.			Rated Capacity of Conveyor system	1100	1.6	X	-----	X -----			Conveyor Belt Speed	800		
		Rated Capacity of Conveyor system	1100												
1.6	X	-----	X -----												
		Conveyor Belt Speed	800												
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5.07.03	Conveyor Gallery structure shall be designed considering both conveyors operating simultaneously. Conveyor gallery and supporting trestles located between transfer houses / buildings shall be arranged in any one of the following ways. a) All gallery supporting trestles shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements. c. OR d. b) In between transfer houses / buildings, four legged trestles shall be placed at a maximum interval of 90 metre. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length) of conveyor gallery of length not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the arrangements. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements. End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa. For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns / ground conveyor portal column base shall be kept 300 mm higher than the existing ground level.		
	Transfer houses The over ground portion of all transfer houses shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding (from lowest working floor level till top) and R. C. C. floors over structural beams. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both side. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. In all transfer points, contractor shall have option to use Tubular steel sections for bracings only. Vertical bracings shall be provided only on four sides along the periphery. Grade slab with 0.9m height one brick thick wall plastered on both side at periphery shall be provided for all transfer houses. Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided		
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5.07.04	on the side cladding for natural lighting. Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. Proper gradient shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183) having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations. Crusher House The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors shall be of R. C. C. supported on steel beams. Within this building, cubicles for resting room of operators shall be constructed with one brick thick brickwork having both sides plastered and roof slab. Adequate steel doors and windows for natural lighting and ventilation shall be provided. In Crusher house, contractor shall have option to use Tubular steel sections for bracings only. Vertical bracings shall be provided only on four sides along the periphery. Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183) having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations. Ring Granulator type Crushers shall be supported on R. C. C. deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This R. C. C. deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework. Detailed specification of vibration isolation system including the unbalanced force (due to ring granulator), frequency and amplitude criteria and other design requirements are appended elsewhere in this specification. 5.07.05 Stacker-Reclaimer/Reclaimer Foundation Stacker-Reclaimer/Reclaimer foundation shall be in R.C.C. and shall be designed as a continuous wall or R.C.C. framed structures (in longitudinal & transverse direction). Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0 m center. The foundation shall be designed for the most critical combination of		
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	loads as furnished by the equipment supplier. R.C.C retaining wall on both sides of the S/R foundation shall be provided as shown in the tender drawing. The portion between the two rails shall be paved in concrete as per specification for grade slab of ground level specified elsewhere. However no metallic hardener finish over R. C. C. slabs is to be provided. Drains shall be provided along the rails for drainage of rain / dust suppression / floor washing water. Drains shall be routed on both sides of the foundation along the rail as shown in Tender Drawing. Drains shall be connected to the network drainage system for finally discharge into coal settling tank. RCC drains shall be provided in Coal stockyard area with precast RCC covers.			
5.07.06	Control building, M. C. C. Buildings These shall be R. C. C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations. All air - conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system (details specified elsewhere) with under deck insulation. Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.			
5.07.07	Pump Houses These shall be framed structure of structural steel work with permanently colour coated profiled steel sheet roof, grade slab and RCC foundations etc.. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. Brick wall (1m height above FFL) shall be provided all around the periphery of pump houses.			
5.07.08	Pent House These shall be of R. C. C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of steel doors and windows shall be provided for natural lighting and ventilation.			
5.07.09	Toilets Toilet with potable water line facilities shall be provided in each of the following locations: a. Crusher House (Ground Floor) b. In all M. C. C./ Control Room building			
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5.07.10	Each unit shall have brick enclosure, and the following fittings.			
	i)	Squatting type, white, vitreous china Orissa pattern, W.C. pan with flush valve and all requisite fittings. In addition, for control building one no. wall mounted glazed vitreous china European water closet with flushing valve shall be provided.	1 No.	
	ii)	White glazed vitreous china flat back lipped urinal with photovoltaic control system for flushing and all requisite fittings	1 No.	
	iii)	Wash Basin 630 mm x 450 mm mounted over granite beveled edge counter fitted with photovoltaic control system for water controls, bottle trap with two taps and all requisite items	1 No.	
	iv)	Mirror 600 mm x 450 mm x 5.5 mm thick with bevelled edges (Superior sheet glass)	1 No.	
	v)	C.P. Brass Towel Rod 600 x 20 mm	1 No.	
	vi)	Liquid Soap Container	2 Nos.	
	vii)	Washing Tap (CP Brass)	1 No.	
	viii)	Overhead Polyethylene water tank (min. 500 litres capacity)	1 No.	
	ix)	Suitable provision for installation of water coolers.		
	x) For control room buildings, pantry with granite top counter & stainless steel sink.	1 No.		
	Staircase			
	All floors of transfer houses/crusher house and roof/floors of all MCC/Control room buildings shall be accessible through staircase. Cage ladders (min. 450mm wide) shall be provided for access to roof of penthouses & mummy.			
	All stairs of overground portion of transfer houses & crusher house shall be of steel (minimum 1000 mm wide)and maximum rise should not be more than 180 mm and minimum tread width 250 mm. Stringers shall be of rolled steel channel(minimum ISMC 250)and tread shall be of electroforged steel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.			
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5.07.11	Handrails (for staircases, around openings, in walkways etc.) shall be of standard weight steel pipe of flush welded constructions, ground smooth using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1.0 metre above platform level and pipe posts spaced not more than 1.5 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases. Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail. Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 600g/m². Out side stairs to transfer points shall be open type. However meeting shall be provided at the top. Stairs of MCC/control room, Wagon tippler and underground TP's shall be of R. C. C. construction. The minimum width of stairs for MCC/Control room shall be 1200mm wide and for reclaim hopper/underground TP's shall be 1000mm. Maximum rise should not be more than 180 mm and minimum tread with 250 mm. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in wagon tippler/underground TP's. Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirements as per guide lines of statutory regulatory bodies. Trenches All trenches for cables or any other underground facility as detailed out elsewhere shall be of R. C. C. Cable trenches shall be provided with pre - cast R. C. C. covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Trench pre - cast cover weight shall not be more than 65 Kgs. At road crossings & entry locations, trench covers designed for 10 T wheel load at centre shall be provided. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers. For cable trenches outside buildings, top level shall be 200 mm above G. L and sand filling shall be overlaid with 50 thk. PCC. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC covers, edges of R. C. C. trenches supporting pre - cast covers, supported edges of pre - cast cover.		
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5.07.12 5.07.12.01	Drainage & Water Supply Works Drainage System:- The drainage arrangements shall be so planned so as to ensure quick disposal of drainage water without stagnation and / or overflow. It is envisaged to clean the conveyor galleries, transfer points, crusher building, penthouse etc. with water periodically. Minimum 4 nos. down comers shall be provided in each transfer house / crusher house. In case of conveyor galleries, the down comer shall be provided at every trestle location. Drainage of the complete coal stock pile, area around stacker reclaimer rails etc. shall be discharged into the coal slurry settling pond. For Conveyors in Main plant area each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally into trunk drain routed alongside the nearby road. For Conveyors in stock pile area, each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C For Crusher House, Pent Houses & TP's in stock pile area, each down comer shall lead the water / coal slurry into the peripheral drains (RCC drains with steel gratings provided around the building) which will lead the water / coal slurry to water / coal slurry to RCC pit (of 2 Cu. M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond. For TP's in Main plant area, each down comer shall lead the water / coal slurry into the peripheral drains (RCC drains with steel gratings provided around the building) which will lead the water / coal slurry to RCC drain and finally into trunk drain routed alongside the nearby road. For wagon tippler complex peripheral drains (RCC drains with steel gratings provided around the building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond. In case of Control rooms and M. C. C. buildings, Pump houses, etc, water / coal slurry coming from down comers shall discharge into peripheral drains (RCC drains with steel gratings provided around the building) which will lead the water / coal slurry into R.C.C drain, which will lead the discharge finally into trunk drain routed alongside the nearby road/ coal settling pond.drain, which will lead the discharge finally to the coal settling pond. Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings. Contractor's scope shall also include construction of necessary culverts under the rail lines / roads as per railway / I. R. C. standards and approval of Railway culverts from concern Railway authorities. 5.07.12.02 Internal and external water supply, drainage etc.:- The scope for potable water supply includes all distribution systems, tanks, pipes, fittings etc. as required and as described here or elsewhere in these specifications.			
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	The scope for service water supply and dust control water supply shall be as described elsewhere in these specifications. For water supply, medium class galvanized mild steel pipes conforming to IS: 1239 shall be used. The scope for drainage of surface water shall include design, layout and construction of drains for and from buildings and drains required for coal stockyard area, drainage up to main coal slurry settling tank including connection with the tank. Drainage system shall be designed for maximum intensity of rainfall as per area drainage study considering min. 60 % runoff coefficient with no retention time. All buildings (including transfer houses and crusher house) shall be provided with RCC drains of minimum size of 300 mm width and 300 mm depth all around the periphery. All open drains shall have removable steel grating designed for loads as specified under loading clause. Minimum size of main bar of grating (Galvanised to 610 gm/m²) shall be 12 mm x 3mm and cross bars 6mm. At all entry or road/rail crossing point's RCC box/pipe culvert shall be provided. The opening size of grating shall not be more than 90 mm x 35 mm. All drains as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. However, drains in coal stockyard area shall have pre-cast R. C. C. covers. RCC pre - cast cover weight shall not be more than 65 Kgs. RCC pre-cast covers near entry or at road crossings shall be designed for 10 T wheel load at centre. RCC pre - cast covers shall be designed for central point load of 75 Kgs. The scope for foul water from toilets shall include layout and laying of sewers up to the main sewer line for sewerage system upto Sewerage Treatment Plant (included in Bidder's scope) together with all fittings and fixtures and inclusive of ancillary works such as connections, manholes and inspection chambers within the building and from the building to the main sewer line. For rain water down comer and those to be used for conveying water / coal slurry generated from cleaning of walkway/floors, Galvanised MS pipes conforming to IS: 1239 (for 150 mm NB Medium grade pipes) with welded joints shall be used for MCC buildings, penthouse, control rooms and Galvanised steel ERW pipes (273mm OD, 4mm thk) of steel grade Fe330 conforming to IS: 3589 with welded joints shall be used for all TP's, Crusher house, and Conveyor galleries. Galvanising shall be as per IS: 4736. The minimum mass of zinc coating shall not be less than 360 gms/sq.m. as per IS:6745. The zinc coating shall be smooth and shall be subjected to testing as per IS: 2633, for uniformity of coating. The zinc coating shall be free from all defects as per IS: 2629. All rain water down comers shall be provided with roof drain heads and complete with shoes bends, junctions, sockets, adapters, brackets and finished with anti corrosive painting over a coat or primer. For design of building drainage system IS: 1742 shall be followed. For sanitary / sewerage pipes above ground, sand cast iron pipes conforming to IS : 1729 with leak proof lead joints. For underground drain pipes, minimum class NP - 2 pipes conforming to IS: 458. At road crossings, concrete pipes of class NP 3 conforming to IS: 458 and at rail crossing R.C.C. box culvert to be provided.			
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5.07.13	For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch. Roof Details Roof slab shall be minimum 150 mm thick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom. 900 mm high and minimum 100 mm thick R. C. C. parapet wall shall be provided over roofs. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings. Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet. Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster. Roofs of all M. C. C./control rooms, penthouse, mumty etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as follows: 1) Application of polymerised mastic over the RCC roof to achieve smooth surface as primer coat. 2) Application of high solid content liquid applied urethane based elastomeric water proofing membrane, over the primer coat, to give uniform joint less dry film thickness of minimum 1.5 mm (as per ASTM C 836 and C 898). 3) For efficient disposal of rain water, the run off gradient for the roof shall not be less than 1: 100. This gradient shall be provided by screed concrete M-15 (using 12.5 mm coarse aggregate) and / or cement mortar (1: 4) over the elastomeric water proofing membrane with 25mm thick cement mortar (1:4) topping. 4) Wearing course at top, shall consist of 25 mm thick P. C. C. (M-15) cast in panels of maximum 1.2 x 1.2 m size and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealing compound / elastomeric water proofing membrane. Pathways for handling of materials and movement of personnel shall be provided with 22 mm thick chequered cement concrete tiles as per IS : 13801 for a width of 900 mm in place of P. C. C. Roof of transfer points and crusher house shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. 5.07.14 Floors and Grade level details The floor slabs shall be minimum 150 mm thick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom Floors of transfer points shall have cross slope of not flatter than 1: 80, towards the floor washing drainage outlets, for efficient drainage. For ground conveyor & crusher house slope shall be 1:100.		
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5.07.15	Chequered plates (used for platforms, walkways etc.) shall be minimum 6 mm thick o/p or as indicated on drawings. The chequered plate pattern shall be approved by Employer / Engineer. Mild steel flats/angles of suitable size shall be welded to the bottom portion of chequered plates at a designed spacing to stiffen chequered plates to restrict deflection within span/200. Chequered plates shall be fixed by staggered welding of suitable size. Toe guard of size 100 x 6 mm shall be provided at various openings provided in floors e.g. around stair case openings, chute openings and other similar cutouts. For conveyor walkways, angle runner to act as toe guard shall be provided. All along the periphery of R. C. C. floors (where no brick masonry walls are provided) shall be provided with one brick thick 300 mm high brick wall and 700 mm high steel hand rails all around over this brick work. The grade slab shall consists of 275 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick R. C. C. of grade M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the R. C. C. slab. All buildings (including wagon tippler complex, godhouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand. An area of 5 m width all round the wagon tippler complex around water tanks near pump house, transfer houses and crusher house shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick metallic hardener finish is not required to be provided in paved area. Plinth level of all buildings shall be kept at least 500 mm above the finished grade / formation level.			
	Fencing Fencing with toe wall and steel gates shall be provided around the transformers. Fencing shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2.4 m above the toe wall. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 12G. All Fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5 m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R. C. C. foundation for the post and stays shall be provided based on prevailing soil conditions. Gates shall be sturdy with locking provisions. Toe walls of brick masonry shall be provided between fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the formation level with 50 mm thick P. C. C. coping (1: 2. 4) and shall extend minimum 300 mm below the formation level. Toe wall shall be plastered on both sides and painted with two coats of cement paint of approved colour and shade. Toe wall shall be provided with weep holes at suitable spacing.			
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5.07.16	LOADING For consideration of loads on structures IS 875 - 'Code of practice for structural safety of buildings' shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration). Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design. The structure and equipment shall also be designed for seismic loads as per the "Criteria for Earthquake Resistant Design of Structures and equipment" and the "Criteria for Wind Resistant Design of Structures and equipment". whichever is governing. Wind and seismic forces shall not be considered to act simultaneously. The following minimum live loads shall be adopted for the design of various structures. If actual expected load is more than the specified load, then actual load is to be considered. <table><tr><td>a)</td><td>Roofs</td><td>150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.</td></tr><tr><td>b)</td><td>R. C. C. floors</td><td>500 Kgs. / Sq. M.</td></tr><tr><td>c)</td><td>Stair and balconies</td><td>500 Kgs. / Sq. M.</td></tr><tr><td>d)</td><td>Toilet rooms</td><td>200 Kgs. / Sq. M.</td></tr><tr><td>e)</td><td>Chequered plate floors</td><td>400 Kgs. / Sq. M.</td></tr><tr><td>f)</td><td>Walkways (including walkways in conveyor/cable galleries)</td><td>300 Kgs. / Sq. M.</td></tr><tr><td>g)</td><td>Conveyor galleries</td><td>In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @ 125 Kgs. / m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes are shown in Tender Drawing.</td></tr><tr><td>h)</td><td>Road Culverts and its allied structures including R. C. C. pipe crossing & road crossing of trenches.</td><td>For class 'AA' loading and checked for class A loading as per IRC standard.</td></tr><tr><td>i)</td><td>Channels / trenches</td><td>In addition to earth pressure and water pressure, etc. additional earth pressure due to surcharge of 2T / Sq. M. shall also be considered for design.</td></tr><tr><td>j)</td><td>Covers for trenches / channels</td><td>Covers for channels & trenches, shall be designed for a live load of 0.4T Sq. M. and loading as mentioned under clause in trenches, whichever is critical.</td></tr></table>				a)	Roofs	150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.	b)	R. C. C. floors	500 Kgs. / Sq. M.	c)	Stair and balconies	500 Kgs. / Sq. M.	d)	Toilet rooms	200 Kgs. / Sq. M.	e)	Chequered plate floors	400 Kgs. / Sq. M.	f)	Walkways (including walkways in conveyor/cable galleries)	300 Kgs. / Sq. M.	g)	Conveyor galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @ 125 Kgs. / m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes are shown in Tender Drawing.	h)	Road Culverts and its allied structures including R. C. C. pipe crossing & road crossing of trenches.	For class 'AA' loading and checked for class A loading as per IRC standard.	i)	Channels / trenches	In addition to earth pressure and water pressure, etc. additional earth pressure due to surcharge of 2T / Sq. M. shall also be considered for design.	j)	Covers for trenches / channels	Covers for channels & trenches, shall be designed for a live load of 0.4T Sq. M. and loading as mentioned under clause in trenches, whichever is critical.
a)	Roofs	150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.																																
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5.07.17	k)	Sumps and tanks and other underground basement type structures	In addition to earth pressure with a surcharge of 2T / Sq. M. (or surcharge due to Railway loading whichever is critical for Railway load bearing structures etc.) and sub - soil water pressure etc. These are also to be designed for the following conditions :	
			i) Water / liquid inside and no earth outside (applicable only to such structures which are liable to be filled up with water or any liquid). ii) Earth with surcharge outside and no water / liquid inside iii) For underground (basement) structures protection against buoyancy during execution and after execution shall be ensured without super imposed loadings with minimum factor of safety of 1.2 against buoyancy.	
	l)	Unit weight of coal shall be taken as 1100 Kgs./ cum. for design purposes.		
	If the erection load is higher than the specified live loads on any floor or part thereof, then the erection loads are to be considered for the design.			
	Permissible increase in stresses of materials and bearing pressure of soil due to wind load or seismic load shall be as per relevant I. R. S. and I. S. code.			
	DESIGN CRITERIA			
	The loads for all railway load bearing structures and the analysis and the design of these structures (if any) shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as "DFC loading (32.5t axle load)" of Heavy mineral loading as per Indian railway standard. The analysis, design and detailed drawing for tunnel, underground transfer houses, culverts etc. coming directly below the railway track shall be got approved by the contractor from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.			
	The design of all R. C. C. structures shall be carried out as per 'code of practice for plain and reinforced concrete for general building construction', IS 456.			
	The steel structures shall be designed and fabricated as per 'code of practice for use of structural steel in general building construction', IS : 800 and other relevant IS Standards. Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. The steel structures using tubular sections shall be designed and fabricated as per IS 806-"code of practice for use of steel tubes in general building construction." And EN 1993-1-8:2005. Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 Mpa & 4.0mm respectively.			
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5.07.18	The building shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41. Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports. All gallery supporting trestles shall be so proportioned that the transverse deflection of gallery due to wind / seismic load should not exceed trestle height / 1000 as stipulated in IS 11592. This deflection condition shall be strictly followed. Peak wind speed method shall be considered for checking the transverse deflection. The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles. Stresses for all CHP structures shall be checked for the higher of the forces obtained from gust factor method and the peak wind speed method. The permissible vertical deflection for beams supporting drive machinery shall be restricted to span / 500 and for other beams it shall be within span / 325. Horizontal bracing system shall be provided at floor levels around the openings. Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement. For design of liquid retaining structures, IS 3370 (Part - I to IV) (latest) shall be followed. Face of the structure in contact with liquid shall be designed as un - cracked section. For design of R. C. C. pipes for culverts, latest editions of IS 458, IS 783 should be followed. For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i.e. the adjoining ground level). Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory. Design of masonry walls shall be made as per IS 1905. Civil task drawing indicating various equipment loading and supporting arrangement and floor loads to be submitted along with the design calculation. For metal roofing and side cladding, the spacing of purlins/runners shall be such that the deflection of metal sheet used is limited to span/250 under adverse loading condition. Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcements are required as per design.		
	CHEMICAL INJECTION GROUTING Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.		
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	For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes. After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.			
5.07.19	POLYMER MODIFIED CEMENTITIOUS COATING			
5.07.19.01	Materials			
	Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%). Portland cement based dry powder. Clean, fine specially prepared quartz sand approximately 0.6 mm size.			
5.07.19.02	Mixing			
	The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.			
5.07.19.03	Properties of Coating			
	It must adhere to wet surface. It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm. Co - efficient of permeability shall be about 5×10^{-10} Cm / Sec. Water absorption after continuous soaking shall not be more than 1 %. The materials shall be permeable under water vapour. The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14. The co - efficient of thermal expansion of the material shall be close to that of concrete.			
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5.07.19.04	Application The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed. (a) For Slurry Mix A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m² in the 2 coats. A lap of 75 mm shall be provided at the joints. The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat. (b) For Brush Topping Mix This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a brush broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any. The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat. Rate of application of coating shall be established to achieve the required thickness.		
5.07.20	SHOTCRETING		
5.07.20.01	General Requirements Generally, shotcreting shall be done in accordance with IS 9012. Reinforcement for shotcreting shall be as detailed below, unless specified otherwise. c. Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting. a. Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied. b. Clear cover to reinforcement mesh shall not be less than 15 mm. Minimum thickness of shotcreting shall be 50 mm. for abrasion resistant work and 25 mm for ordinary surface protection work.		
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5.07.20.02	Material Generally, the materials shall be in accordance with aggregates specification given hereunder. Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS 383. Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS 9012. The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.		
5.07.20.03	Application After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting. The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed, not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required. A uniform pressure of not less than 3 Kg/cm² at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine. The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused. As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38°C during placing and curing.		
5.07.21	VIBRATION ISOLATION SYSTEM These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal crushers (ring granulators).		
5.07.21.01	Supporting Arrangement		
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	The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an R. C. C. deck supported on steel helical spring units and viscous damper units which in turn shall be supported on girders. The girders shall be an integral part of the crusher house building. The part of the structure consisting of the R. C. C. deck, springs and viscous dampers shall hitherto be referred to as “spring supported foundation”. The part of the structure, which is below the spring shall hitherto be called “supporting structure”.			
5.07.21.02	The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck which in turn would support the coal crushers. The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for atleast five years.			
5.07.21.03	Scope of Work Scope of work shall include the following:			
5.07.21.04	Engineering			
5.07.21.04.1	Design of the vibration isolation system using steel helical springs and viscous dampers to support an R. C. C. top deck supporting the coal crusher. This includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the coal crusher.			
5.07.21.04.2	Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.			
5.07.21.04.3	Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.			
5.07.21.04.4	Drawings showing embedments and their locations and details on the R. C. C. top deck.			
5.07.21.04.5	Drawings showing block outs, recesses etc. on the top deck.			
5.07.21.04.6	Design of the supporting structure, including preparation of detailed drawings and bill of material.			
5.07.21.05	Supply including packing and transportation to site			
5.07.21.05.1	Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.			
5.07.21.05.2	Frame (s) for pre-stressing of spring elements.			
5.07.21.05.3	Suitable hydraulic jacks system including electric pumps, high pressure tubes etc. required for the installation, alignment etc. of the spring units, two extra hydraulic jacks, one hand operated pump and spares for the hydraulic jack system as required.			
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5.07.21.06	Erection and Commissioning		
5.07.21.06.1	Complete erection and commissioning of the vibration isolation system including :		
5.07.21.06.2	Pre-stressing of spring elements, placing of spring elements in position, checking clearances on the shuttering of the R. C. C. top deck, construction of the supporting structure and the R. C. C. top deck, releasing to pre-stress in spring elements and making final adjustments and alignments after machine installation etc.		
5.07.21.06.3	The scope of work shall be deemed to include all activities which may not have been explicitly mentioned but are reasonably implied for the successful completion of the work for which these specifications are intended.		
5.07.21.06.4	This part of the specifications is for vibration isolation system. For the construction of the supporting structure for the crusher and the top deck, the relevant parts of the specification should be referred to.		
5.07.21.07	Documentation		
5.07.21.07.1	Submission of detailed design calculation, analysis (static and dynamic) and drawings for Employer's acceptance and approval.		
5.07.21.07.2	Furnishing methodology of providing shuttering and its removal as well as concreting of deck slab, installation of springs and dampers and the sequence of operation.		
5.07.21.07.3	Furnishing installation and maintenance manual indicating equipment, procedure etc., necessary for installation, maintenance of vibration isolation system.		
5.07.21.07.4	Furnishing a check list for confirming the readiness of the civil fronts for the installation of vibration isolation system and equipment required at each stage installation.		
5.07.21.07.5	Bill of materials of various elements such as springs, visco-dampers, with their rating, stiffness etc., included in supply.		
5.07.21.07.6	Detailed specifications of the vibration isolation system and various items included in the supply and the standards (local or international) to which they conform.		
5.07.21.07.7	Proposed erection strategy of the entire system.		
5.07.21.08	Design Requirements for Crusher (Ring Granulator) Foundation		
	Dynamic Analysis		
	Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three - dimensional beam / plate finite elements for the purpose of analysis with the spring idealised with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.		
	Natural frequencies upto at least 10 % above the operating speed shall be determined and these frequencies shall be checked against the design criteria.		
	Forced response dynamic analysis shall be carried out for the operating condition unbalance		
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	forces using a sinusoidal forcing function. Unbalance forces as given by this specifications shall be used for his purpose. The amplitudes shall be checked against the design criteria. The dynamic forces from this analysis shall be used for structural design with a suitable fatigue factor. Isolation Efficiency The vibration isolation system shall be designed for about 90 % isolation efficiency. De-coupling A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out. Frequency Criteria The frequency criterion has already been laid down implicitly in the isolation efficiency criteria and de-coupling required. The first bending mode frequency of the top deck shall be at least 20 % above the operating speed. Unbalance Forces Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes. c. Balance quality grade Q 40 as per VDI 2060 - 1966. d. One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non - drive end of the crusher. e. Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non - drive end of the crusher. Amplitude Criteria The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions. 1) Operating speed of 750 RPM f. 150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 - 1966. g. 300 microns in case of a one hammer broken condition. h. Amplitudes need not be checked for a three hammer broken condition. Operating speed of 450 RPM			
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5.07.21.09 5.07.21.10 5.07.21.11	200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI -2060-1966. 400 microns in case of a one hammers broken condition. Amplitude need not be checked for a three hammer broken condition. For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated. The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the R. C. C. deck. The amplitudes shall be checked for the most unfavorable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes. Transient Resonance Transient resonance, which may occur during the start - up or coasting down condition of the crusher, shall be checked, and the amplitudes in such condition should not exceed one - and - half times those at operating speed for each design condition. Strength Criteria The following criteria shall apply for the design of top deck : - Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavorable combination shall considered for design. - Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together - Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used in all dynamic forces to arrive at the equivalent static force for the purpose of design. - Working stress method shall be used for the design of R. C. C. deck. In survival condition, 10 % overstressing may be permitted. - The R. C. C. top deck shall be at least of M25 grade of concrete as per IS : 456 - 1978. - Fatigue need not be considered for the three hammer broken condition. - For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered. Approval of Designs and Drawings All design calculation, drawings and documents shall be in English. All design calculations and drawings shall be submitted to Employer for approval. However, approval of such designs and drawings shall not relieve the contractor of his responsibility regarding the adequacy of the foundation to carry the design forces.		
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5.08.00	Ash Handling System & Ash Water Recirculation System			
5.08.01	The civil works for Ash handling system (both wet and dry) shall comprise of bottom ash and fly ash handling systems, which includes Ash slurry pump house, Ash water pump house, BA slurry pump house and their related sumps/tanks, Transport/Instrument Air Compressor house, HCSD(high concentrated slurry disposal) Pump House, Switchgear /Control/RIO rooms, supporting structures and foundations for Bottom ash hopper, Buffer hoppers/Collector tanks, bottom ash overflow tank, Settling tanks and Surge tanks, HCSD silos , Silo Utility Building complex with Fly Ash Silos including development of silo area (i.e. paving, fencing/boundary-wall, access roads, office block and watchman cabin), miscellaneous equipment foundations, trenches, pipe racks, pedestals/thrust blocks for HCSD / BA pipe supports (both inside and outside the plant boundary) including bridges/culverts for road/rail/nallah , HCSD silo area complex including fencing, paving , gates, drains etc., as required.			
5.08.02	All buildings for Compressor house , Silo utility building and pump houses shall have RCC framed structure, with RCC columns and profiled metal deck sheet roofing (filled with RCC) supported on main steel truss / girders. Other buildings like MCC /switchgear rooms, control room etc. will have RCC framed structure with cast-in-situ RCC roof slabs. All buildings shall have brick cladding. Crane girders or mono rails shall be provided as per requirement and the same shall be of structural steel construction.			
5.08.03	The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only. a) Project design intent document giving the basis of design, which shall cover all the design philosophy aspects, parameters, assumptions, references, loading cases, load combinations, analysis and design of all buildings, structures, facilities etc. shall be furnished for approval, before commencement of detailed engineering. b) Structural analysis, design calculations and drawings of substructures and super structures for all buildings/structures, facilities like pump houses, compressor houses, sumps / tanks, channels, pipe support structures, culverts/ bridges, pedestals, thrust blocks transformer yards, etc shall be submitted for approval of the owner. c) The design and drawings for the equipments and their supporting structures like bottom ash hopper, buffer hopper/collector tanks, surge tank/settling tank, silos/bins, etc. associated with Ash Handling System, shall be submitted to NTPC for information only. However, the structural design criteria and basis of design as mentioned at (a) above, for these structures also shall be approved by the Owner			
5.08.04	The finished ground level (FGL) of Ash Water Recirculation (AWR) pump house complex shall be minimum 1.5 m above high flood level (HFL) & finished floor level (FFL) shall be 500 mm above FGL. However, in order to facilitate approach/connection to the road on top of ash dyke with AWR pump house complex, if required FGL may be fixed at higher level than 1.5 m above HFL. AWR System shall include Ash water recirculation pump house complex near ash dyke along with related sumps/tanks, MCC/Switchgear building, maintenance room, control room, disaster management room(single story room of approx. size 15 m x 7.5 m and 1.5m wide verandah along the larger dimension), transformer yard, miscellaneous equipment foundations, trenches inside roads/RCC paving and area drainage etc. The peripheral drain inside the complex of suitable capacity & slope shall be suitably connected to the natural drain available outside the complex. The AWRPH complex shall be confined with boundary wall and a security gate. The complex shall be suitably connected to the road to plant and			
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5.08.05	road on ash dyke top. Since the complex is situated outside the plant boundary, an independent sewerage system including soak pit/ inspection chamber shall be provided The Silo utility building complex shall be fenced with chain linked fencing, if placed inside the plant boundary and shall be confined with boundary wall if placed out side plant boundary. Gates shall be provided for rails, truck movement and transformers. The boundary wall shall be of one brick thick of height 2.4 m with a 600 mm high galvanized concentrina at top, such that total height is 3.0 m above formation level. The fencing shall be PVC coated G.I. Chain link of minimum 4 mm thickness (including PVC coating) of mesh size 75mm x 75 mm and of height 2.4 m above toe wall .The toewall shall be 1 brick thick, minimum 200 mm high above paving/formation level and 300 mm below paving/formation level on 75 mm thick pcc(1:4:8) bedding. Entire area in the silo area complex shall be paved and have a peripheral RCC drain of adequate capacity & slopes covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers of 1.0 m at every 4 m interval .The complex shall be provided with a sump for collection of ash water. In addition to the outer confinement, additional fencing with gates should be provided for all transformers in the complex. A watchman cabin with a minimum area of 5 Sqm shall also be provided in this area.		
5.08.06	For AWR system, the pedestals/thrust blocks for pipe supports from ash dyke to AWR sump & AWRPH to ash water PH including bridges/ culverts for road/rail/nallah etc, shall be provided as per the system requirement. The pedestals for AWR pipes may be combined with the pedestals for Bottom ash pipes or HCSD pipes in the corridor common for pipes. Pipe supports shall be provided for bottom ash slurry pipes, ash slurry pipes , AWR pipes, dust suppression pipes, dry fly ash(FA) pipes including RCC thrust blocks and any other supports required to complete the system. Over ground pipes shall be supported on RCC pedestals except for FA pipes which shall be on steel trestles. Unless noted otherwise, the top of concrete pedestals shall be minimum 500 mm above ground. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements as per system requirement.		
5.08.07	B.A. slurry disposal pipe line pedestals and thrust block/culverts including garlanding of bottom ash slurry dyke and RCC stairway type energy dissipation channel at discharge points on the inside slope of ash dyke shall be provided. The inside width of stairway shall be minimum 2000 mm, which shall be extended into ash dyke area by a minimum of 3 metre beyond the heel of the dyke. The side walls of dissipation channel shall be 200 mm thick and and 1200 mm high above base slab. The base slab also shall be 200 mm thick on 75 mm thick PCC. Reinforcement at 8 tor @ 200 c/c on both faces both ways for base slab & walls shall be provided. For the stairway, the riser shall be 500 mm and tread shall be as per the dyke slope.		
5.08.08	If the layout requires the pipes to cross the road on top of ash dyke, all ash pipes shall be laid in hume pipes of suitable dia (NP-3 class) encased in RCC(minimum 200 mm thick) forming a hump on the road. The road shall be modified such that the slope of road along the length, at hump section, shall not be steeper than 1:20.		
5.08.09	Single lane maintenance / Inspection road with 1.5m wide shoulders on both sides of the road shall be provided along the route of the ash slurry pipeline from plant boundary wall to the ash dyke along ash pipe lines. The details of road shall be as specified elsewhere for patrol road in the specification. However shoulders shall consist of 150mm thick compacted layer of moorum in place of interlocking blocks specified therein. For stretches of roads in cutting and other stretches wherever necessary, longitudinal rectangular brick side drains with minimum 500 wide and 300 deep shall be provided. Only, the inside faces and top surfaces of the drains shall be plastered with 1:4 (cement : sand mortar) . These drains shall be connected to the nearest available natural drain or low lying area. Adequate cross drainage with RCC box culvert or RCC pipe culverts (NP-3) as per topography requirement		
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	shall be provided under the access/maintenance road to cater to the surface drainage due to rainfall and other existing drain/nallah . Camber shall be provided on the road. The finished top (crest) of all roads shall be minimum 350 mm above the surrounding finished ground level, however based on the site conditions / low lying areas the height of road top shall be increased. However, in the AWRPH complex it shall be minimum 250 mm above FGL.			
5.08.10	Where the pipes are crossing the road through RCC box culverts, the culvert top generally, shall not be not more than 100 mm above the road top and a hump with slope of 1:35 shall be provided on the road. All other road crossings inside the plant area can be either underground or over head road crossings with necessary headroom clearance. For any boundary wall crossings, pipe shall be laid through casing pipe / RCC culvert. After laying the pipe, the boundary wall shall be restored. For other water body crossings, such as local Nallah / canal , local water bodies, local drains etc. suitable structural arrangement with 800 mm wide walkway shall be provided. Minimum clearance of the bottom of pipeline for all such locations shall be 1.50 M above the High flood level (HFL). Bidder to take all statutory clearance from concerned authorities for crossing his pipe/trestles over road / rail / culverts / nallah etc. at his own cost and initiative, without any commercial implication to the owner. For any other additional works, bidder have to make their own assessment too of the quantity/ number of culverts, existing pipe pedestal crossings, nallah crossings etc., based on their site visit before quoting.			
5.08.11	All ash handling system/ ash water recirculation system pipe crossings with Railway Lines including MGR lines shall be laid by thrust boring for existing rail lines & by cast in situ RCC box culvert for future envisaged rail lines. The railway track crossings are to be designed in accordance with railway Standard/RDSO guidelines and all necessary approvals from the concerned Railway authorities shall be obtained by the Bidder, without any financial implications to the owner.			
5.08.12	Survey inside and outside plant boundary , required for finalization of layout for maintenance road , FA transportation pipe trestles, bottom ash slurry disposal pipe lines and HCSD slurry disposal pipelines upto ash dyke, is in the bidder's scope. The survey shall include the longitudinal section of the entire corridor			
5.08.13	All RCC liquid retaining/conveying structures shall be designed in accordance with IS:3370 (Part 1 & 2):2009. The design shall be carried out by limit state method as outlined in clause 4.4 of IS 3370(Part 2):2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130MPa(on all faces) as per clause no. 4.4.3.1 of IS3370(Part 2):2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3			
5.08.14	The thickness of base slab in liquid retaining/ carrying structures shall be minimum 150mm The minimum reinforcement in each direction shall not be less than 0.24% of the gross cross-sectional area.			
5.08.15	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with clause no.12 of IS:3370(Part 1):2009 and IS:6494.			
5.08.16	All pump houses and other substructures shall be checked fo stability as per the following guidelines:- a) Stability of structure against sliding during construction as well as operating conditions for various combinations of applied characteristic loads. In case where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Factor of safety against sliding shall not be less than 1.4 under most adverse combination of applied characteristic loads. b) Stability of structure as a whole against overturning. It shall be ensured that the			
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	resisting moment shall be not less than the F.O.S. times the maximum overturning moment. Factor of safety against overturning shall not be less than 1.2 due to characteristic dead load and shall not be less than 1.4 due to characteristic imposed load. c) Stability of structure against uplift due to the ground water table at finished ground levels during construction and after construction stages. Minimum factor of safety of 1.2 against uplift shall be ensured considering 0.9 times dead weight, empty condition inside and ignoring the superimposed loadings. Inclined wedge action shall be limited to 15 degree with vertical plane. Provision of pressure relief valve / flap valves etc. shall not be permitted to counter the uplift. Also FOS against uplift, to be taken as 1.0 considering the dead weight of structure and soil resting on side projections, if any, in the vertical plane. Inclined wedge action of soil shall not be considered in this case.		
5.08.17	Architectural Features of Ash Handling System Buildings: All the buildings shall be fully covered with brick masonry / cladding and doors/ windows/ rolling shutters / ventilators. Safety norms shall be followed as applicable. The buildings shall be provided for Pump houses, Switch Gear Room, Control room etc. as per ash handling and ash water recirculation system requirements. External finish shall be of solvent based paint.		
5.09.00	Sewerage System Cement concrete pipes of class III as per IS:458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, spun C.I. pipes conforming to IS:1536 of required class shall be used. RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS:4111. Sewage pump house shall be provided as per IS:4111. Sewage treatment plant is to be provided by the Bidder. Bidder shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used.		
5.10.00	Plant Storm Water Drainage System Plant storm water drain shall be designed taking into account the finished ground levels of the plant area, drainage pattern, intensity of rainfall, etc with a return period of 50 years. These values shall be based on the "Detailed Area Drainage Study" subject to minimum rainfall intensity of 75mm/hr. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M25 for RCC Cast-In-Situ drains and M30 for RCC Pre-cast drains. The maximum velocity for RCC open drains shall be limited to 1.8 metre per second. However, minimum velocity of 0.6 metre per second for self - cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. Open RCC rectangular section, unless required otherwise due to functional requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 200 mm or as per design considerations whichever is higher. The drains shall be provided on both sides of the double lane roads and single lane roads. The drains		
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5.11.00 5.12.00	shall be provided on one side of the patrol roads. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings. RCC drains located within and along both sides of peripheral roads of the main plant shall be covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 metre intervals. Similarly all artillery drains and the drains along the periphery of all buildings shall also have perforated precast RCC cover of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 metre intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. All drains in the main plant area shall be provided with heavy duty galvanized steel grating. All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. The invert levels of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main / trunk drains under all conditions. The invert levels of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level. Diversion Of Existing Drainage And Discharge Of Plant Drainage Into Natural Drainage System All existing drains crossing the project / site shall be diverted suitably and shall be discharged into a natural drainage outside plant boundary. The controlled drainage from plant area and ash pond shall also be discharged at a single point. The final disposal point shall be same which is indicated for diverted drains. Bidder scope shall be upto an existing natural drain. All external discharge / diversion drains shall be in trapezoidal section lined with 150mm thick RCC in M20 grade concrete. The natural drain / hallah (Osali River) for the discharge of plant drainage is about 3.5 Kms from plant. The controlled drainage from plant area, ash pond, township including the discharge of all existing drains crossing project/site shall be discharged in this natural drain and accordingly the chain from Plant Boundary to natural drain shall be sized accordingly. Roads All roads shall be of rigid pavements unless otherwise specified. The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. Detailed plate load tests to determine the modulus of sub grade reaction "K" shall be carried out as per the procedure outlined in IS: 1888. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.			
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5.12.01	The road construction including its shoulders, base, sub base and concrete pavement shall be as per IRC standards. IRC: 58 shall be followed for the pavement design and IRC: 15 shall be followed for the construction of the concrete pavement. The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques. Dry lean concrete shall be minimum M10 grade and concrete pavement slab shall be minimum M35 grade concrete. The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level. The sub grade under all roads and its shoulders shall be compacted to achieve 95 per cent or more of Standard Proctor's Density MDD using mechanical means. Cutting / extending / rerouting / remaking of existing roads including associated works to maintain continuity of road system / network shall also be carried out. All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed. Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads. Double lane roads: The double lane roads shall be (12 metres wide) with 7.5 metres wide concrete pavement and 2.25 metres wide raised shoulders on both sides of the roads. The raised shoulders (on both sides of the road) shall comprise of 75mm thick inter locking precast designer concrete blocks (M35 grade) at the top, over 20 mm thick sand layer. A 200mm diameter NP3 pipes shall carry the surface water from the road through a PCC drain trench (M20) on both sides of the roads to the drain. The pipes shall run over PCC (M 20) continuous cradle bedding. The pipes shall be laid at 10 metres centre to centre. A layer of 100 mm (average) thick PCC (M15) shall be laid over the pipes and below the sand layer. All roads shall be provided with edge protection on both sides of the road using pre - cast kerb blocks (450 mm long x 250 mm wide x 500 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.				
	5.12.02	Single lane roads: All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads. These shall be single lane roads (6.75 metres wide) with 3.75 metres wide concrete pavement and 1.5 metres wide shoulders on both sides of the roads. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.			
	5.12.03	Patrol roads:			
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5.13.00	All patrol roads along the boundary wall shall be single lane roads with 3.75 metres wide concrete pavement and 1.5 metres wide shoulders on one side of the road. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar. The road shall slope towards the inner drain. The centre line of the black top of the road shall run at a distance not less than 2625 mm from the centre line of the boundary wall. Administration Building Salient Features The Administration Building shall be a multi-storeyed RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lifts. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm. Design Concept The building shall be designed as moment resisting RCC sway frame in both the orthogonal directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed. Architectural Features This building shall be five storeyed (G+4 stories above) and area 5000 sq.m. with RCC Frame structure & Autoclave Aerated concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. The building shall have a central atrium covered with polycarbonate sheet dome. Hermetically sealed double glazing with toughened Glass to be provided for external glazing. There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, AHU., MCC Room, First Aid Centre, Library, offices. In addition, adequate space shall be provided for IT & Communication Area. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms. The Administrative Building shall also have adequate floor area reserved for SATCOM building. 2Nos Panoramic Lifts and minimum 2Nos stairs shall be provided. The provision for car and scooter parking shall be made. The space for parking facility shall be worked out based on the following method Car parking - 75% of executives' strength housed in Administration Building (20 sq.m./car), Scooter parking - 75% of executives' strength housed in Administration Building (5 sq.m./Scooter). Space for visitor's car parking shall also be kept. The rain water down comers shall be provided as per General architectural specification. The rain water down comers shall be suitably concealed by the external wall enclosure. External finish shall be combination of solvent based exterior paint & aluminium composite		
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5.14.00	panel. Plant Auditorium Salient Features Plant Auditorium shall be a multi-storeyed RCC framed superstructure. The building shall have large span Roof structure over the Auditorium Hall. The large span roof structure shall comprise either RCC beams (with camber at bottom surface) and roof slab or structural steel girders/ roof truss (with adequate lateral stability through tie & rafter level bracings / girders in orthogonal direction) and RCC slab over profiled metal deck sheets with purlins. All the external wall shall be of Autoclaved aerated concrete block wall 250 thick for this fully covered Auditorium with additional internal & external plastering. Handrail for all balconies & staircases shall be made of stainless steel. Floor wall and false ceiling details shall be as per architectural specification. Architectural Features: This building shall be of RCC Frame structure & Autoclave Aerated Concrete Block masonry. The area of building shall be 1000 sq.m. and shall have seating capacity of 150 persons. There shall be provisions for Main Entrance Lobby, Lounge, AHU, AC Plant room, MCC room, stage, Green rooms, pantry etc. Separate toilet facilities shall be provided for Ladies & Gents & physically handicapped people. Provisions for air-conditioning for the building for all the areas except toilets, and other service areas shall be kept. External finishing shall be of solvent based paint, and Coloured Aluminium Composite panel. False ceiling & wall panelling shall be provided as per Acoustical consideration. The rainwater down comers shall be provided as per General Arch. Specification and they shall be suitably concealed inside wall enclosure. External finish shall be combination of solvent based exterior paint & aluminium composite panel. 5.15.00 Main Gate Complex & CISF Building The Gate Complex shall comprise two(2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates. Two(2) separate mild steel pedestrian gates minimum 3.0m high and 3.0m width shall be provided at the each end. The Central Industrial Security Force (CISF) Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with 250mm thick brick wall with provisions for doors, windows & ventilators. The first floor shall also have a viewing gallery. The floor area and architectural details shall be as per the Arch spec. mentioned hereafter in this Specification. Design Concept:		
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5.16.00	The CISF building shall be designed as moment resisting sway frame in both orthogonal directions and shall be designed as per IS: 456, IS: 1893 and IS: 13920 (for seismic ductility requirement) and as per design criteria mentioned hereafter in this specification. Architectural Features The CISF Building shall be 2-storied building. It shall be of RCC Frame structure& Brick masonry. The floor area of this building shall be minimum 700 sq m The Gate Complex and CISF building shall have sufficient no: of guards rooms to regulate movement of men and material and overall security, using latest modern technology like turnstile type/ boom type access control with magnetic cards and close circuit TV sets, computerized time and security office, etc shall be made. For any other gate provided for entry or exit, provision for a suitable small security hut/shed shall be made. Space provision for CISF personal staff, time office including time machine, reception, lounge, Arms store, Detention Room, Conference room, Toilets and pantry shall be provided as per functional requirement including toilets for Ladies, Gents, Physically handicapped. In addition, provision for space for open parking (for trucks, cars, scooters, cycles) and covered parking for staff shall be provided. External finishing shall be of solvent based exterior paint & Aluminium Composite Panel combination. Gates Along Boundary Wall: The gates shall be provided at the entry & exit points of ash bunker movement road, at the entry of railway line, at the entry of material access road to the plant, at the entry of plant from township. No. of gates in Bidder's Scope are as identified in General Layout Plan Drawing No.: 9578-999-POC-F-001. The gate shall comprise of two mild steel double panelled openable shutter of minimum 7.75 m clear width and minimum height of 3.0m from top of road. The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminum ball bearing, castor wheel etc. All gates shall be given anti-corrosive treatment in three coats. The structural steel shall confirm to IS: 2062 (latest) and all other relevant IS codes. Beside the each gate one room of size not less than 3m X 3m shall be provided for security guards. The room shall be made of brick/ RCC and with RCC roof. In addition to the room, one toilet block shall also be provided.			
	Permanent Store Building Salient Features: The scope of work of the Bidder shall be design & construction of all Civil, Structural, and Architectural, Water supply, plumbing & sanitary works of the Permanent Store Building including supply of all materials. The Permanent Store Building shall comprise the following			
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	a) Heavy Material Storage Hall b) Light Material storage Hall (With 3 tier Racking System) c) General Light Material Storage Hall d) Office Complex. a) The Heavy Material Storage Hall shall have a Single Bay framed superstructure with RCC/ Structural steel columns and structural steel roof truss. The roof of the Heavy Material Store shall be 40mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. An EOT crane shall be provided with chequered plate walkways at both ends inside the bay of the Heavy Storage Hall. The capacity of the EOT crane shall be 30 T. The clear height up to the bottom of roof truss of the Heavy material storage hall shall be finalized based on equipment/ spare to be handled. b) The Light Material Storage Hall with 3 tier Rack system shall have a Single Bay framed superstructure with RCC/ structural steel columns and roof truss. The roof of light material Light Material Store shall be 40 mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. The light material store shall be fully covered with external brick wall of 250 mm thickness with provision for doors, windows, rolling shutters as per architectural concept. c) The General Light Material Store shall be RCC structure with cast-in-situ RCC beams & slabs. The RCC building shall be two storied and all beam-column joints shall be designed and detailed for adequate ductility. d) The office complex of this store shall be a single storeyed RCC building. Architectural Features Total floor area of the Permanent store building shall be 3000sqm. The minimum clear floor area of Heavy material storage Hall shall be approximately 20% of the total floor area of the Permanent Store with bay width of 15m. Heavy material store shall have column free space for easy movement of materials. The Heavy Material Storage Hall shall be fully covered with external brick wall of 250mm thickness with provisions for doors, windows, rolling shutters as per architectural concept. The minimum clear floor area of Light Material Storage Hall (with 3 tier storage) shall be approximately 33% of the total floor area of the Permanent Store. The height of the Light Material Storage Hall (with 3 tier rack system) from ground floor slab to bottom of roof truss shall be 10.0m. A part of light material store shall have facility for storing electronic equipment / instruments. This particular area shall be air-conditioned for dust proof environment. The General Light Material Store shall be two storied building, completely covered with 250mm thick brickwork, doors, windows & rolling shutters. The plan of the building shall be rectangular in shape with minimum floor area of approximately 20% of the total floor area of the Permanent Store. The area of the office complex building shall be approximately 17% of the total floor area of the Permanent Store, with clear height of 4.0m and provision for air-conditioning. The external Wall shall be 250mm thick brick wall with provisions for doors and windows. The central office shall be provided for management and monitoring the stored materials. Adequate space shall be kept for loading unloading of materials. Office shall space for		
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5.17.00	Supervisor/In-Charge room, general office cum record-documentation area, toilets, pantry, etc. shall be provided as per requirement.		
	All the above mentioned four buildings shall be interconnected by means of a covered passage 5.0m wide.		
	External finish shall be of solvent based paint.		
	Facilities to be provided in Railway siding & CHP area		
5.18.00	The scope of the bidder shall include all development work in the railway siding yard and CHP area such as leveling of the yard with good quality earth upto the level as mentioned in GLP for site leveling work in railway siding area and CHP area, including road works & Drainage system connecting various facilities, buildings etc. The bridges/culverts for crossing of rail tracks by various utilities (pipelines, cross-country drainage etc) are to be designed as per Railway/RDSO guidelines / specifications. In addition, the top levels of the bridges/ culverts or any other structure crossing the railway track are to be finalized by the bidder in consultation with Railway approved consultant appointed by the owner for undertaking the construction of railway siding system.		
	The bidder has to obtain all statutory approvals from the relevant RDSO/railway authorities before undertaking the construction activities. Any statutory payment charges to be made to the concerned authorities shall be to Bidders account. It is the responsibility of the bidder to carryout any modifications as required by the RDSO/Railway authorities at no extra cost to the Owner. Bidder has to submit to the owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings to the owner.		
5.19.00	The construction of rail network inside the plant for transportation of coal, fly ash & POL is in the scope of Owner. The bidder has to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding.		
5.18.00	Not Used		
5.19.00	FIRE WATER PUMP HOUSE, FOAM PUMP HOUSE AND FIRE WATER BOOSTER PUMP HOUSE		
	Salient Features:		
	The scope of the Bidder shall be design and construction of Civil, Structural, Architectural, Water Supply, Plumbing and Sanitary Works of Fire Water Pump House, Foam Pump House and Fire Water Booster Pump House including supply of all materials.		
	The fire water Pump House shall be single storeyed and single bay RCC superstructure. The pump house shall be provided with monorail electric hoist of not less than 5T capacity. The building shall be fully covered with 230mm thick external brick wall with provision for doors, windows, rolling shutters and exhaust fans.		
	The Foam Pump House shall be a single storeyed RCC superstructure with provision for a structural steel monorail (2T capacity) supported from the RCC roof beams. The building shall be fully covered with 230mm thick external brick wall with provision for doors, windows, rolling shutters and exhaust fans.		
	The Fire Water Booster Pump House shall be a single storeyed RCC superstructure. The building shall be fully covered with 230mm thick external brick wall with provision for doors, windows, rolling shutters and exhaust fans.		
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	Architectural feature: External finish shall be solvent based paint. Fire Water Tank Foundation: The fire water tank foundations shall be provided inline with Cl. 5.05.04, as specified for DM	
5.20.00	Raw Water Reservoir	
5.20.01	Scope The scope of work for Raw water reservoir generally involves design, preparation of general arrangement drawings, construction drawings, supply of labour, materials and construction of all civil and structural works like site clearance, site leveling & grading, excavation, filling, construction of earthen embankment, providing sand filters, sand chimney, sand blanket in embankment, cut-off trench, mechanical compaction, slope protection, HDPE lining, pre-cast concrete tiles, Inlet and Outlet Structures, RCC spillways, supplying & laying of MS pipes, road works, construction of fencing and drains along the reservoir boundary etc. and other ancillary works associated with the completion of reservoir as per directions of the Engineer.	
5.20.02	General Requirements Raw water reservoir shall have net usable capacity of 3, 80,000 Cu.m excluding dead storage. The proposed raw water reservoir shall cater 7 days of plant operation with 48 cusec withdrawal capacity. The allocated area for reservoir is about 40 acres.	
5.20.03	Design Requirement Sizing of the reservoir shall be such so as to utilize the maximum allocated area for the reservoir as per the layout drawing of the plant and as directed by the Owner. Bottom 500 mm (minimum) depth of water shall be treated as dead storage for settlement of any silt etc. The dead storage shall be over and above the total required capacity of the reservoir. The reservoir shall be provided with a free board as per requirements of IS:10635, but in no case, the same shall be less than 1500mm. The reservoir shall be divided into two compartments of equal sizes with separate inlet and outlet arrangements for each compartment. Both the portion of the reservoir shall be kept filled throughout the year and both together shall have a net usable capacity of about 3, 80,000 Cu.m excluding additional capacity. Earthen embankment shall be designed as an earthen dam as per IS: 12169 with internal drainage system i.e. sand chimney and sand blanket of 500mm (min.) thickness shall be provided inside the embankment. Slope stability of embankment shall be analyzed as per IS: 7894. However, the minimum slope of embankment shall be 1V:2.5H with a berm of 3.0m at every 6.0m interval. The founding level of embankment shall be atleast 300mm below natural ground level. The top soil shall be stripped to a minimum depth of 300mm. However, the stripping depth, if required, shall be increased to the required level as per actual conditions to totally remove all vegetations, organic matters, roots, soft spots, etc. The existing ground level of the reservoir area is varying approximately from RL(+) 253 M to RL(+) 260.0 M and as per available data water table has not been encountered upto the depth of exploration. The whole area of reservoir bed shall be graded & leveled by cutting and filling. Wherever filling is required at the bed of the reservoir, area shall be stripped first and then embankment filling shall be done in layers of 300mm compacted thickness and compacted to	
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5.20.04	minimum 90% of maximum dry density (Standard Proctor) by mechanical means at optimum moisture content. As per bore log data, rock is at shallow depth and excavation in rock shall be done by mechanical means/blasting. Finishing shall be done by 4 passes of flat footed rollers of 8-10 ton capacity to break any rock extrusion/projection. Wherever cutting is required at the bed of reservoir, bed shall be prepared by laying a layer of min 300mm thick soil measured from the highest rock projection. Soil used for this layer shall be free from shingle, salts, sharp objects, organic roots, sods, lumps or any other foreign substances. Top level of embankment shall not exceed RL(+) 255.5m unless otherwise approved by the Owner. Minimum top width of embankment shall be 6.0m with provision of single lane WBM road including black topping all around on top of embankment. WBM road shall be constructed in accordance with IRC: 19 (latest edition). On downstream slope of the embankment, rip-rap shall be provided upto or higher level than the HFL. Turfing shall be provided from embankment top to rip-rap level. Rock-toe with toe drain shall be provided at the toe (bottom) of the embankment all around the reservoir. Toe drain shall be of adequate capacity to be constructed in brick masonry. An approach ramp of minimum 6m width and min. 1V:8H slope shall be provided for access to the top of reservoir embankment along with single lane WBM road including black topping. The side slope of rip embankment shall be minimum 1V:2.5H and shall be provided with rip-rap/turfing (as required) on side slopes. In order to arrest the seepage/percolation losses through reservoir bed/embankment, 1mm thick high density polyethylene (HDPE) liner shall be provided at entire bed and upstream side slopes. HDPE liner shall be laid on the prepared soil bed which is free from any sharp objects, roots or any other organic materials. HDPE liner shall be anchored in PCC filled trench at the edge of top of embankment. HDPE liner shall be protected by providing 50mm thick precast concrete tiles of M-25 grade concrete (with 10mm nominal size aggregates). Pre-cast concrete tile shall be of size 300x300x50mm and shall be laid over 18mm thick 1:6 cement sand mortar. Pre-cast concrete tiles over HDPE shall cover complete side slopes of upstream and about 20m from the heel of embankment.		
	Earthen Embankment Material For Filling Material to be used for embankment filling shall be of approved quality excavated from inside the reservoir/plant area or brought from borrow area arranged by the Contractor. Material used in embankment filling shall not be organic soils, peat, cohesionless soil, sand dust, expansive soils and chemically aggressive soils. They shall be clean and free from shingle, salts, organic roots and sod, lumps, concrete or any other foreign substances. Fill shall be placed in horizontal layers not exceeding 300 mm compacted thicknesses. Compaction shall be done to achieve minimum 95% standard Proctor density by mechanical means. Filling shall be accurately finished to line, slope, cross-section and grade as shown on the approved drawings. Finished surface shall be free of irregularities and depressions and shall be within (+/-) 20mm of the specified level. When the borrow area is located contiguous to the embankment alignment then it must be ensured that the borrow area shall not be opened within a distance of 5 times the height of embankment contiguous to the heel or the toe of the embankment or 25 metres whichever is more.		
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	The required approach roads and haul roads shall be constructed and maintained by the Bidder. The Bidder shall divert the existing roads, nallah/drain if any which are in the Raw Water Reservoir area at his own cost before the start of work. Frequency of sampling and testing including the methods for conducting the tests are as given in Table-1. The testing frequencies set forth are desirable minimum and Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. Following Acceptance Criteria shall be followed: a. All individual samples collected and tested should pass without any deviation when only one set of sample is tested. b. For re-test of any sample, two additional samples shall be collected and tested, and both should pass without any deviation. c. Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.			
5.20.05	Sand Blanket, Chimney and Filter Sand Blanket shall be laid subsequent to foundation preparation. The prepared foundation shall be approved before laying the blanket material. The material for blanket, chimney and sand filters shall consist of clean sound and well graded coarse sand. The materials shall be free from debris, wood, vegetable matter and other deleterious matter. The gradation of sand material shall meet the requirements as specified in IS 9429 – 1999. The filter material shall be suitably compacted to a firm condition to achieve a relative density of 70%.			
5.20.06	Graded Coarse Aggregate Filters Graded coarse aggregate shall be used in filters below rip-rap and rock-toe as per IS:8237. The coarse aggregate material shall consist of durable well graded broken rock of hard stone. The materials shall range in the size from 10mm to 75mm and shall satisfy the filter criteria. The rock material used in the aggregate filters shall satisfy the following condition: a) Specific gravity shall not be less than 2.50. (As per IS: 1122) b) Sulphate soundness less than 10% loss of weight after 5 (Five) cycles (As per IS: 1126) c) Aggregate Impact value shall not exceed 30% (As per IS: 2386) d) Water absorption shall not exceed 2.5% (As per IS: 2386) e) In slake durability test (as per IS: 10050), the percentage retained after two ten (10) minutes cycles shall be more than 85%.			
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5.20.07	Cut-Off Trench Cut-off trench shall be provided in the portion upstream of sand chimney, to increase the drainage path of any seepage occurring at the junction between the embankment and its foundation. A minimum bottom width of 4m shall be provided for the cut-off trench to facilitate compaction with rollers. A depth of 1.5m (Min) may be adopted with 1:1 side slope in earth. If rock is available at a depth less than 1.5 metre, the cut-off trench may be stopped at the rock level itself. It shall be filled up in layers not exceeding 300mm in compacted thickness using impervious soils CL or CI type having permeability less than 1×10^{-6} cm/sec, to be obtained by the Contractor. The effect of cut-off trench shall not be taken in the design and it is only provided as an additional precaution against piping failure in foundation.			
5.20.08	HDPE Liner The Specification as outlined hereunder shall be treated as bare minimum. However, bidder shall offer a system to meet the site specific requirements. Bidder shall guarantee the satisfactory performance of the proposed liner system for a period of 5 years from the date of installation. The bidder shall also provide a warranty for the proposed liner system for an additional period of 15 years (subsequent to 5 year guarantee period) for successful functioning of the liner system against the intended use. The guarantee shall be provided in a manner acceptable to the owner. The HDPE Liner shall be executed at site by the supplier of HDPE liner only. The High Density Polyethylene (HDPE) Liner shall be manufactured out of polyethylene resin. The resin composition and production shall meet the intended purpose as specified above. The natural polyethylene resin without the carbon black shall meet density requirement of 0.942 g/cc and melt index less than 1.0 g/10min. The test methods shall conform to ASTM D 1505 or ASTM D792 or equivalent for density test and ASTM D1238, condition E or equivalent for Melt Index test. The HDPE liner shall not be less than 6.0 M in width. Carbon Black shall be included in the resin to render it ultra-violet resistant. The Carbon Black content shall not be less than 2 percent as per ASTM D 1503. The surface of liner shall not have striations, roughness, pinholes or bubbles. The liner may be smooth or textured. The liner sheet thickness shall be 1.0MM (40 Mil) with sheet density not less than 0.94 g/cu.cm. The Melt Flow Index shall be less than 1.0 g/10min. The method for testing melt flow index shall be as per ASTM D 1238 or equivalent. The Tensile stress at yield shall not be less than 17.0 N/mm and the yield strain not less than 12%. The strain at break shall not be less than 700%. The Tear Strength as per ASTM D 1004 or equivalent shall not be less than 130 N. The Puncture Resistance as per ASTM D 4833 (or equivalent) shall not be less than 390 N. Any sealants used shall be of type as per the recommendations of the HDPE manufacturer compatible with the intended use. However, before the use, Owner's approval shall be obtained. All quality control measures shall be deployed by the bidder. All tests are required to be carried out at Bidder's own cost during the production of materials as well as during laying operation. All resins for use in geo-membrane shall conform to the requirements. Each lot shall be sampled with following tests conforming to manufactures specifications.			
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	1. Density. : ASTM D 1505 2. Melt Index : ASTM D 1238 3. Infrared (Ir) spectroscopy analysis for additives: 4. Oxidative induction Time (OIT) : ASTM D 3895 All additives are to be tested and approved prior to use with the following testing performed and compared to the manufacture's requirements'. 1. Carbon Black content : ASTM D 1603 2. Oxidative induction Time (OIT) : ASTM D 3895 Manufacturer's quality Assurance Testing shall conform to the provisions as stipulated here. Full width samples shall be taken as tokens from the end of each roll. The geo-membrane that is to be supplied, quality control testing shall meet following frequency. <table><tr><th>Test</th><th>Description</th><th>Method</th><th>Frequency</th></tr><tr><td>1.</td><td>Thickness</td><td>ASTM D 5199</td><td>Every roll</td></tr><tr><td>2.</td><td>Tensile properties</td><td>ASTM D 638</td><td>Every 5000 sq.m.</td></tr><tr><td></td><td>a. Tensile strength at yield.</td><td></td><td></td></tr><tr><td></td><td>b. Tensile strength at Break</td><td></td><td></td></tr><tr><td></td><td>c. Elongation at Yield.</td><td></td><td></td></tr><tr><td></td><td>d. Elongation at Break.</td><td></td><td></td></tr><tr><td>3.</td><td>Tear resistance</td><td>ASTM D 1004</td><td>-do-</td></tr><tr><td>4.</td><td>Puncture Resistance</td><td>ASTM D 4833</td><td>-do-</td></tr><tr><td>5.</td><td>Carbon Black Content</td><td>ASTM D 1603</td><td>-do-</td></tr><tr><td>6.</td><td>Puncture Resistance</td><td>ASTM D 4833</td><td>Everyday once</td></tr><tr><td>7.</td><td>Modulus of Elasticity</td><td>ASTM D 638</td><td>- do-</td></tr><tr><td>8.</td><td>Dimensional Stability</td><td>ASTM D 1204</td><td>- do-</td></tr><tr><td>9.</td><td>Carbon Black Dispersion</td><td>ASTM D 3015</td><td>- do-</td></tr><tr><td>10.</td><td>Density</td><td>ASTM D 1505</td><td>- do-</td></tr><tr><td>11.</td><td>Melt Index</td><td>ASTM D 1238</td><td>- do-</td></tr><tr><td>12.</td><td>Oxidative Induction Time</td><td>ASTM D 3895</td><td>- do-</td></tr><tr><td>13.</td><td>Low Temperature Brittleness</td><td>ASTM S 746</td><td>One per resin lot</td></tr><tr><td>14.</td><td>Environmental Stress resistance</td><td>ASTM D 1693</td><td>-do-</td></tr></table> Welding rod samples shall be tested at the frequency of once per 25 rolls of welding rod. Following tests shall be performed on the samples. 1. Thickness as per ASTMD 751 : ASTMD 751 2. Density as per ASTM D 1505 : ASTMD 1505 3. Melt Index as per ASTM D 1238 : ASTMD 1238 4. Carbon Black Content as per : ASTMD 1603				Test	Description	Method	Frequency	1.	Thickness	ASTM D 5199	Every roll	2.	Tensile properties	ASTM D 638	Every 5000 sq.m.		a. Tensile strength at yield.				b. Tensile strength at Break				c. Elongation at Yield.				d. Elongation at Break.			3.	Tear resistance	ASTM D 1004	-do-	4.	Puncture Resistance	ASTM D 4833	-do-	5.	Carbon Black Content	ASTM D 1603	-do-	6.	Puncture Resistance	ASTM D 4833	Everyday once	7.	Modulus of Elasticity	ASTM D 638	- do-	8.	Dimensional Stability	ASTM D 1204	- do-	9.	Carbon Black Dispersion	ASTM D 3015	- do-	10.	Density	ASTM D 1505	- do-	11.	Melt Index	ASTM D 1238	- do-	12.	Oxidative Induction Time	ASTM D 3895	- do-	13.	Low Temperature Brittleness	ASTM S 746	One per resin lot	14.	Environmental Stress resistance	ASTM D 1693	-do-
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5.20.09	ASTM D 1603 All the reference to ASTM codes shall be tested as the base requirement. Other International codes of practices, which are equivalent to the above ASTM, shall also be acceptable to the owner subject to prior approval. Results of all the tests shall be furnished to the owner for his review. Owner or his authorized representative reserve the right to inspect the testing facilities and witness the tests as and when desired. Precast Concrete Blocks/Tiles The Precast concrete blocks/tile of grade M-25 and specified size shall be used as protective layer over 18mm thick cement sand mortar on HDPE liner at the bed of reservoir upto the specified width and on upstream side slopes of embankment. The concrete tiles shall be free from impurities like particles of stone, lime and other foreign materials visible to the naked eye on the surface and shall be of uniform texture. The exposed joints between the tiles of protective layer shall be raked out properly and the dust and loose mortar shall be brushed out. The surface shall then be wetted before pointing. The mortar shall be pressed into the raked out joints and shall be finished off flush and level with the edges of the block so as to give smooth appearance. Placing After the slope has been dressed to line and HDPE liner has been provided over the sand layer, the entire upstream slope surface shall then be covered with 50mm thick Precast concrete tiles of specified size and specified grade over 18mm thick cement sand mortar on HDPE liner at the bed of reservoir and on upstream side slopes of embankment. The concrete tiles shall be free from impurities like particles of stone, lime and other foreign materials visible to the naked eye on the surface and shall be of uniform texture. The concrete tiles shall be laid over 18mm thick cement sand mortar in close contact. The exposed joints between the tiles of protective layer shall be raked out properly and the dust and loose mortar shall be brushed out. The surface shall then be wetted before pointing. The mortar shall be pressed into the raked out joints and shall be finished off flush and level with the edges of the block so as to give smooth appearance. After completion of the laying of concrete tiles, the top joints shall be pointed with cement mortar of 1:6 (1 cement: 6 coarse sand) proportion. On completion of concrete lining, the surface presented by the lining shall be even throughout, free from irregularities.		
	5.20.10 Spillways/Over Flow Structures Bidder shall suitably design and construct spillways/over flow structures to prevent overtopping of the embankment. It will be provided one in each compartment and one between the two compartments. The discharge from the spillways/overflow structures shall flow to the nearest nallah or drains with capacity to accommodate it.		
	5.20.11 Inlet /Outlet Structures Suitable separate outlet pipes of mild steel (MS) as per IS: 3589 shall be provided from both the compartments of the reservoir to the raw water pump house. The adequate nos. of outlet pipes (as per design requirement) of suitable diameter and minimum 500mm thick RCC encasement with concrete Grade M20 as per IS: 456. Pipes shall be laid as per IS: 783.		
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5.20.12	Separate Inlet structure into both compartments shall be suitably designed & constructed. Inlet pipes shall be of MS as per IS: 3589 and laying shall be done as per IS: 783. The nos and diameter of pipes shall be suitably designed to meet the capacity requirement. A minimum 500mm thick RCC encasement with concrete Grade M20 as per IS: 456 within the embankment shall be provided. To dissipate the turbulence and energy of the falling water suitable energy dissipation devices/system shall be provided. Rip-Rap Rip-rap shall be hand placed on the slopes of the embankment as per IS: 8237 - "Code of practice for Protection of slope for reservoir embankments". The thickness shall be 300mm and shall be measured normal to slope of the embankment. The rock materials used for rip-rap shall satisfy the quality requirements specified in IS code.				
5.20.13	Rock Toe The rock material used for the rock toe shall satisfy the quality requirements. Rock toe shall be formed with rock material consisting of sound, durable and well graded broken rock obtained from approved quarries and shall be of approved quality. The materials shall range in size from 10 to 45 cm. All brush, roots or other perishable materials shall be removed from rock-fill during spreading and disposal off. Contamination of the rock with finer materials from any other zones shall be avoided. Accumulations of silt caused by contamination shall be removed. Rock materials shall not be dumped directly but shall be hand placed in layers.				
5.20.14	D/S Slope Protection Works – Turfing The D/S slope of embankment including berms, if any, shall be turf sodded from top of embankment to rip-rap level. Turfing shall consist of atleast 5 cm thick grass turf sods of approved variety obtained from the tank bed or river margins for use in this work. The sod shall include a mat of roots and earth atleast 5cm thick. Sod containing an excessive amount of obnoxious weed growth shall be excluded. The block of sod shall be laid on the slope in close contact and then tamped firmly in place so as to fill and close the joints between blocks.				
5.20.15	Fencing & Gates Fencing all around the Raw Water Reservoir area & gates shall be provided. The specifications shall be as mentioned elsewhere in the specification.				
5.20.16	Diversion On Surface & Under Ground Water The whole of the works shall be carried out in the dry condition. Water from any source shall be diverted or pumped as required, clear of the works. Bidder shall make all necessary arrangement whatsoever required for keeping the work area dried by diverting and pumping of water, and also provision and operation of all temporary works including pumps, motors, fuel, piping and for the formation of any sumps, drainage channels, flumes, coffer dams and other protective works.				
5.20.17	Rainfall Run-Off As part of the work may have to be carried out in wet season, Bidders programme and methods must be capable of dealing with run-off from rainfall on the adjacent catchment area. The associated flow in the nallahs etc. shall be diverted clear of the works by an approved system of bunds and channels. Bidder shall supply, install and operate his own temporary pumping installation.				
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5.20.18	Prevention Of Pollution Arrangement shall be made by the Bidder to prevent pollution of the water in any streams, springs, nallahs and lakes. Arrangements for sprinkling of water in the construction and borrow area to prevent any dust blowing also shall be done by the Bidder. Bidder shall be solely responsible and liable for all damage caused by any pollution that may take place during the execution of the works, and he shall make arrangements, as the Engineer may approve, for preventing pollution but, notwithstanding such approval, the entire responsibility for any pollution shall rest with the Bidder. Table-1 Frequency of sampling and testing <table> <tr> <th>S.No.</th><th>Nature of test/Characteristics</th><th>Method of test</th><th>No. of samples & frequency of test</th><th>Remarks</th></tr> <tr> <td rowspan="10">1</td><td>Suitability of fill material</td><td></td><td>One in every 2500 cum for each type and each source of fill materials subject to a minimum of two samples</td><td>Test for soil and sand</td></tr> <tr> <td>a) Grain size analysis</td><td>IS: 2720 (Part-IV)</td><td></td><td></td></tr> <tr> <td>b) Liquid limit and Plastic limit</td><td>IS: 2720 (Part-V)</td><td></td><td></td></tr> <tr> <td>c) Shrinkage limit</td><td>IS: 2720 (Part-VI)</td><td></td><td>Test for soil</td></tr> <tr> <td>d) Free swell index</td><td>IS: 2720 (Part-XL)</td><td>One in every 5000 cum for each type and each source of fill material</td><td>The frequency of test can be increased depending on type of soil</td></tr> <tr> <td>e) Chemical Analysis</td><td>IS: 2720</td><td></td><td></td></tr> <tr> <td>i) organic matter</td><td>Part-XXII</td><td rowspan="4">One in every 5000 cum for each type and each source of fill material</td><td rowspan="4">Test for soil and sand</td></tr> <tr> <td>ii) calcium carbonate</td><td>Part-XXIII</td></tr> <tr> <td>iii) Ph</td><td>Part-XXVI</td></tr> <tr> <td>iv) total soluble sulphate</td><td>Part-XXVII</td></tr> <tr> <td>2.</td><td>Standard proctor Test</td><td>IS: 2720 (Part-VII)</td><td>One in every 2000 cum for each type and each source of fill material</td><td>Test for soil for determining optimum moisture content, dry density etc</td></tr> <tr> <td>3.</td><td>Moisture content for fill before compaction</td><td>IS: 2720 (Part-II)</td><td>One in every 2000 cum for each type and each source of fill material</td><td>Test for soil</td></tr> <tr> <td>4.</td><td>Degree of compaction of fill</td><td></td><td></td><td></td></tr> <tr> <td></td><td>a) Dry density by</td><td>IS: 2720 (Part-</td><td>For area filling,</td><td>Test for soil</td></tr> </table>				S.No.	Nature of test/Characteristics	Method of test	No. of samples & frequency of test	Remarks	1	Suitability of fill material		One in every 2500 cum for each type and each source of fill materials subject to a minimum of two samples	Test for soil and sand	a) Grain size analysis	IS: 2720 (Part-IV)			b) Liquid limit and Plastic limit	IS: 2720 (Part-V)			c) Shrinkage limit	IS: 2720 (Part-VI)		Test for soil	d) Free swell index	IS: 2720 (Part-XL)	One in every 5000 cum for each type and each source of fill material	The frequency of test can be increased depending on type of soil	e) Chemical Analysis	IS: 2720			i) organic matter	Part-XXII	One in every 5000 cum for each type and each source of fill material	Test for soil and sand	ii) calcium carbonate	Part-XXIII	iii) Ph	Part-XXVI	iv) total soluble sulphate	Part-XXVII	2.	Standard proctor Test	IS: 2720 (Part-VII)	One in every 2000 cum for each type and each source of fill material	Test for soil for determining optimum moisture content, dry density etc	3.	Moisture content for fill before compaction	IS: 2720 (Part-II)	One in every 2000 cum for each type and each source of fill material	Test for soil	4.	Degree of compaction of fill					a) Dry density by	IS: 2720 (Part-	For area filling,	Test for soil
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5.21.00		core cutter method or dry density in place for sand displacement method	XXIX)	one for every 1000 sqm area for each compacted layer	
		b) Relative density (density Index)	IS: 2720 (Part-Xiv)	For area filling, one for every 1000 sqm area for each compacted layer	Test for soil
		c) Dry Density for proctor needle penetration	Standard practice	Random checks to be carried out for each compacted layer in addition to tests mentioned under IV(a) above	Test for soil
	Fuel Oil Handling system The civil works are to be provided for following fuel oil handling system areas as mentioned below: - Fuel Oil pressurizing pump house. - Foundation and dyke wall and all associated works for LDO and HFO tanks. - Peristals and foundations to support the interconnecting piping between HFO tanks and LDO tanks to the pressurizing pumps as well as piping from tanker unloading area to the Unloading pump house and further on to the LDO tank and also redescals from railway unloading trench to unloading pump house - Tanker unloading platform. - Fuel Oil Unloading Pump House. - Oil water separator pit. Fuel Oil Pressurising Pump House Salient Features: This building shall be a single storeyed framed superstructure with RCC columns, structural steel roof truss(with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise 40 thick RCC slab supported on profiled metal deck sheet. Waterproofing on Roof slab shall be done as per architectural specifications. The building shall be completely				
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	covered with 250mm thick brick wall with provisions for Doors, windows, rolling shutters. the building shall have separate enclosures for the control room and the switchgear room. All rainwater down comers shall be concealed with brick wall. The minimum floor area of this building shall be as per the equipment layout plan of the bidder/ EPC contractor. Design Concept: The grade of concrete shall be M 25 for all columns, beams, footing and slabs. The building shall be designed as per IS: 456, IS 800, IS 1893, IS 13920 (for ductility detailing) The Fuel Oil Storage Tank foundations shall be either RCC raft or RCC Ring Beam system with compacted infill. The RCC raft /RCC ring beam shall be supported on virgin soil or pile foundation depending on the load bearing capacity of the soil. The tank bottom base plate shall be supported on flexible compacted fill comprising 75mm thk Bitumen aggregate mix on top and compacted sand/ soil fill below, compacted in layers of 200mm to minimum 85% relative density as per IS:2720. The bitumen-aggregate mix shall consist of compact crushed stone, screenings, fine gravel, clean coarse sand(river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. In the GA & detailing of foundation RCC ring wall/ beam it should be ensured that no bearing stress from tank superstructure is transmitted to the concrete surface. The top of flexible compact fill and top of RCC Circular wall shall be atleast 325mm above the surrounding ground surface for effective drainage. The finished tank grade(Top surface of flexible compact fill) shall be crowned from its outer periphery to its centre at a slope of 1 in 100. The Tank foundations shall be inside a RCC dyke wall enclosure. The entire area outside the tank foundations and within the surrounding RCC dyke walls shall be paved with concrete. The thickness of concrete paving shall be minimum 100mm. The single layer reinforcement in paving slab shall be min 10 Tor@200c/c. The area paving RCC slab shall be supported on 230mm thick Rubble along with the internal voids filled with coarse sand. The height of the RCC dyke wall shall be evaluated based on the depth of Oil spillage for full oil volume of one storage Tank in addition to a free board of 300mm. Structural steel cross over ladder shall be provided (min 2 numbers) for each RCC wall dyke enclosure. Operating platforms wherever required as per functional requirement shall be provided. The road tanker unloading platform shall be heavy duty RCC paving minimum 250 thk RCC slab resting on elevated compacted ground surface. A minimum slope of 1:250 shall be provided (in one direction) for the slab for Oil-Water Surface run-off to the peripheral drain. Expansion joints shall be provided in chess board fashion. RCC ramp shall be provided for approach of truck The rail tanker unloading platform shall be based on the railway guidelines and statutory rules. Fuel Oil Unloading Pump house shall be a covered building with RCC columns and Structural Steel Roof truss. 250mm thick external brick wall shall be provided with provisions for fire proof door, windows & rolling shutters. The basement RCC slab & RCC wall shall be designed as for uplift and external surcharge load as per the design criteria specified elsewhere. All fuel oil pump foundations shall be designed for both static & dynamic loading. The roof slab shall comprise 40th RCC slab over profiled permanent metal deck sheet (min 0.80mm thick) connected through shear anchor studs specified elsewhere in this specification. The Oil-Water Separator RCC structure (pit) shall be designed as an underground structure. The sizing of the separator shall be based on the total surface run-off from the Fuel Oil Handling area and Hydraulic design for the oil separation. Surcharge load and ground water		
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5.22.00	table up to ground surface shall be considered in addition to other functional loads for structural design of RCC wall for the separator pit. Drainage trenches with proper bed slopes towards the oil-water separator pit shall be provided around the tank foundation. The entire area outside tank foundation shall have slope towards the drain trenches Foundation for trestles and pedestal foundations, for supporting the pipes, shall be provided wherever required, at appropriate spacings. At pipe bends, necessary thrust resisting arrangement shall be provided. The entire fuel Oil Handling area shall be fenced all round with minimum 1.50m high metal fencing with provision for gates at key locations. Seismic design shall be carried out for the Fuel Oil Storage Tank foundation, Fuel Oil Unloading Pump House & the Oil water separator. Architectural Features of Fuel Oil Handling Buildings: Spaces for Pump Rooms, MCC Rooms, Control Rooms, etc shall be provided as per functional requirement. External finishing shall be of solvent based paint O&M Workshop Building The O&M Workshop Building shall be a two bay fully covered building. The two bays shall comprise of workshop bay and office complex bay. The minimum span of workshop bay shall be 25m with RCC columns, structural steel roof truss and 40mm thick RCC roof slab supported on troughed permanently colour coated metal decking sheet and purlins. Roof water proofing shall be applied on roof slab as per details specified elsewhere in this specification. The Gantry girder for the EOT crane in the workshop building shall be structural steel plate girder supported on RCC corbels at column locations. The gantry girder shall be complete with chequered plate walkways (at both sides) and the cage ladder. The adjacent Office complex bay shall have RCC superstructure. The minimum bay width shall be 6.50m. Architectural Features: The building shall be fully covered with brick wall masonry. provision of doors, windows & Rolling shutters shall be included based on architectural detailed drawing to be developed by the bidder. The rainwater down comers shall be provided at every column location and they shall be suitably connected to the building surface drain. The minimum operating floor area for the workshop bay shall be 25mX110m. The minimum head room of workshop bay shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level. The office complex shall preferably be 6.50mX110m in plan area. The office complex shall preferably be made 2 storied for adequate space for operating personnel, MCC room, stores, Laboratories, Toilets, Conference room & Tool room. The floor to floor/ roof clear height shall be 4.50m.		
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5.23.00	Canteen Salient Features: The Canteen Building shall be a RCC framed superstructure with large span roof system. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement) Architectural Features This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1000 sq.m. The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc. External finish shall be of solvent based paint. There shall be separate service road and entrance for supply of cooking materials and garbage disposal.			
5.24.00	Fire Station Building Salient Features: The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement) Architectural Features It shall be of RCC Frame structure& Brick masonry. The building shall be provided with area 600 sq m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. The number of fire tenders shall be provided as per CISF norms. One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dinning Hall, Rest Rooms, Stores, First Aid Room shall be provided as applicable. External finish shall be of solvent based paint.			
5.25.00	Dozer Shed Architectural Feature This building shall be Steel structure with brick masonry / Metal Panel cladding with RCC slab, metal roofing. The building shall provide for Dozer shed space, Workshop space, Office Rooms, Stores, Toilet& Pantry as per functional requirement. Bull dozer shed shall preferably be 20x20.5x8m high excluding parking/ washing space of 12x20.5m. Metal side cladding shall be composed of different colour shades to match with the other buildings. External finish for brick walls shall be of solvent based paint.			
5.26.00	Area Paving in Main Plant Block RCC paving of minimum 150 mm thick with M25 grade concrete, over an underbed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The underbed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thick for normal duty paving and 400mm compacted thick for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum followed by 75 mm thick 1:4:8 PCC (1 part cement, 4 parts sand and 8 parts stone aggregate) with 40			
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	mm nominal size aggregate. Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification. Entire main plant area from chimney to transformer yard as enclosed within the peripheral roads of the main plant area shall be provided with paving (on chimney side, paving shall be upto the edge of the storm water drain by Bidder. Passages shall be provided inside the main plant block connecting to the outer periphery road to have access to the various facilities/buildings. The passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping. Heavy duty paving shall be provided for the areas in the Mill bunker building, equipment lay down area in the TG hall and handling areas for PA/FD fans with 50 mm thick metallic hardener topping. The ground floor area in the boiler shall also be provided with normal duty paving and shall be finished with 50 mm thick metallic hardener topping. Lightly loaded areas such as corridors below trestle and other areas in the main plant block where no heavy traffic movement is envisaged shall be provided with interlocking concrete block paving with RCC concrete blocks of minimum M 35 grade and minimum 80 mm thickness underlain by 200mm thick with 63 mm and down aggregate with interstices filled with selected moorum. All other area inside the main plant block shall be provided with normal duty paving. 2.5 m wide paving around periphery of all sumps and underground tanks without metallic hardner. Suitable drains shall be provided to dispose off storm water as well as floor wash of the main plant block. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. Drains shall be provided to dispose the floor wash water of ESP to a sump of suitable size. Further, the overflow from the sump to be drained to the nearest storm water drain. Sewer lines (Cast iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from ESP area, CD bay & transformer yard area to sewage pump house.			
5.27.00	Hydrogen Generation Plant Building Architectural Features: This building shall be RCC Frame structure with brick masonry. This building falls under hazardous building category. The entire building campus shall be properly fenced to prevent unauthorised ingress or egress. External finish shall be of solvent based paint			
5.28.00	Conveyer's gallery Architectural Features: This shall be Steel frame structure with Single skin Metal Panel on sides and top roofing. There shall be M.S. louvered windows and fixed glazing of polycarbonate sheets.			
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5.29.00	CW Pump House Architectural Features: External Finish shall be of solvent based paint			
5.30.00	Cooling Tower Switch Gear Room/Control Room Architectural Features: External Finish shall be of solvent based paint			
5.31.00	Switchyard Control Room Building Architectural Features: External Finish shall be of solvent based paint			
5.32.00	DM & PT Plant Structure Architectural Features: External finish shall be of solvent based paint.			
5.33.00	Owner's Construction Office: This building shall be a single storyed building and shall be provided with floor area of 2800 sq.m. with brick masonry wall and RCC frame structure. Floor to Roof height shall be minimum 4.25 m. and the design of building shall give emphasis on swift construction of building and architectural character of the building. The building shall be a Air Conditioned Building with efficient lighting system and shall be provided with aluminium false ceiling and Mineral fiber board false ceiling with under deck insulation and over deck insulation on Roof covered with reflective china clay tile. The building shall provide offices for senior officer , V.I.P. lounge, conference room for 50 persons, small conference rooms, large office halls for various departments like Electrical, Mechanical, Civil etc., as per functional requirement. All full height Partitions, low height modular partition, work stations, Table, Chair and Sofa etc. shall be provided (of reputed manufacturer like Godrej, Jasani or equivalent) to make it ready to occupy office space. Attached toilets shall be provided with Senior officer rooms and conference room. Adequate number of Ladies and Gents toilets and pantry as per National Building Code requirement shall be provided. One no of toilet shall be provided for physically handicapped people. Hermetically sealed Double glass glazing with toughened glass and Aluminium frame shall be provided for exterior Glazing and Doors. The provision for car and scooter parking shall be made. The space for parking facility shall be worked out based on the following method Car parking - 75% of executives' strength housed in Building (20 sq.m./car) , Scooter parking- 75% of executives' strength housed in Building (5 sq.m./Scooter). Space for visitor's car parking shall also be kept. External finishing shall be of solvent based exterior paint and Colored Aluminium Composite Panel combination.			
5.34.00	Ash Dyke Maintenance building: The building shall be single storyed and shall be provided with floor area of 100 sq.m. with RCC frame structure .Provision of space for staffs and other facilities shall be made. External finishing shall be of solvent based exterior paint			
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5.35.00	~~Sewage Treatment Plant~~ A permanent sewage treatment plant (extended aeration type) is to be provided to cater to the sewage discharge of the plant area. The treatment plant shall be so designed as to meet the requirements of applicable local by-laws/pollution standards and conditions as stipulated by the State/Central agencies while according environment clearance to the project. Provision shall also be made for collection and disposal of solid waste.			
5.36.00	Balance Buildings For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements.			
6.00.00	DESIGN CRITERIA			
6.01.01	General The design criteria given herein is applicable for all structures and buildings including Main Plant buildings, Control building, office/service building, Mill and Bunker building, Coal Conveyor Galleries/Trestles, Transfer Points, Track hopper, Tunnel, Pent house, Stack-reclaimer supporting structure, Crusher house, Chimney, Cooling towers, Fuel Oil Handling Plant, Light Diesel Oil Handling System, Pump Houses, C.W. ducts, Compressor house, D.G. Set building, switch gear and other miscellaneous buildings, Culverts, Bridges, Water retaining/carrying structures, Boiler/ESP supporting structures, Switchyard structures, Ash Silos, Roads, Drains, Sewers, Cables and pipe trestles, all ash handling/ ash water recirculation system buildings / facilities and various other works included in the scope of the bidder.			
6.01.02	Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static, friction and dynamic), earth pressure & surcharge loads, Hydrostatic & Hydrodynamic loads, wind loads, seismic loads and temperature loads. In addition, Erection loads, loads and forces developed due to differential settlement shall also be considered.			
6.01.03	i) All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction. Columns having depth of 400mm & less shall have bracing in single plane and at the centerline of column. For columns having depth of 500mm & above, the longitudinal bracings shall comprise a pair of members (spaced) with spacing equal to the column depth. Only where axial bracing to one vertical plane is to be waived due to functional requirement, columns in that vertical plane may be allowed to undergo biaxial bending. Beam column joints shall be detailed as per seismic resistant joint with adequate ductility. All 2-legged structural steel trestles shall be completely braced in the vertical plane. All 4-legged structural steel trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway. If the superstructure is RCC structure, the superstructure shall be moment resisting sway frame in both orthogonal direction and all the members shall be designed for biaxial bending. Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. ii) The Main Plant building, Bunker building, transfer towers, conveyor galleries and			
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6.02.00 6.02.01 6.02.02	trestles, crusher house, boiler, ESP Control Building, ESP supporting structures, including inlet and exhaust duct support structures, Air Washer Building, Compressor House, Pipe cable Gallery shall have structural steel framed super structure.			
	iii) All other buildings may have either RCC or structural steel framework.			
	iv) All buildings having RCC framing shall have masonry cladding of minimum one masonry unit thickness (not less than 225 mm.) on exterior face.			
	v) All buildings, having structural steel frame work shall have non insulated metal cladding on exterior face above the masonry work and RCC roof over permanent metal deck shuttering, except in areas subjected to heavy loads where RCC roofing without metal deck shall be provided. For Mill & bunker buildings and TPs, insulated metal sheeting roof shall be provided.			
	Loading			
	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-I)			
	Imposed loads			
	Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.			
	For consideration of imposed loads on structures, IS:875 (Part-2) “Code of practice for design loads (other than earthquake) for buildings and structures” shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.			
	Sl.No.	Location	Imposed Loads (T/Sq.m.)	
	A)	Turbine Building		
	i)	Ground floor (general)	2.50	
	ii)	Ground floor (heavy equipment storage area)	5.00	
	iii)	Mezzanine floor	1.00	
	iv)	Operating floor		
		a) Rotor Removal area	5.00	
		b) Equipment lay-down area	3.50	
		c) Other areas (corridors, etc.)	1.50	
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	v) Gratings, chequered floors, walkways, platforms, stairs, etc., 0.50 vi) Roof (Where no equipment is located) 0.15 vii) Roof (where equipment are located) 0.50 B) Deaerator and Heater Bay i) H.P/L.P. heater floor 1.00 ii) Deaerator floor 1.00 iii) Cable gallery (In addition to this, actual cable load shall be considered) 0.50 iv) MCC, switchgear and Control building floors 1.00 v) Roof (Where no equipment are located) 0.15 (Where equipment are located) 0.5 vi) A.H.U Room, Battery Room, Air Washer Room 1.0 C) Mill and Bunker Bay i) Ground floor 2.5 ii) Feeder floor 0.50 iii) Tripper floor 0.50 iv) Roof 0.15 (Where no equipment are located) 0.50 (Where equipment are located) 0.075 (For Inaccessible roof) D) Pump Houses Operating floor 1.50 E) Maintenance bay (CWPH & RWPH) 3.0 F) Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc. In addition to earth pressure and ground water pressure, the surcharge load of		
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	2T/sq.m. shall also be considered for design of all underground structures. G) Road Culverts/Bridges and its allied structures including RCC Pipe Crossings and Road Crossing of Trenches. Design for class 'AA' loading (wheeled and tracked both) and checked for class 'A' loading as per IRC Standard. H) Covers for Channels/trenches 0.40 (General) or central point load of 75 kg whichever is higher As per IRC Standard (at road crossings for vehicular traffic) I) Railway Supporting Structures, Rail Culverts As per Railway 'Bridge Rules' J) Boiler/ ESP Support Structures 0.50 K) Conveyor Galleries In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @125Kg/m(minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes L) General (Unless Specified Otherwise) i) Stairs, Landings and Balconies 0.50 ii) Toilets 0.20 iii) Chequered plates, grating floors, etc., 0.50 iv) RCC floors (General) 0.50 v) a) Flat Roofs (where no equipment are located) 0.15 b) Flat Roofs (where equipment are located) 0.50 c) Inaccessible roof 0.075 vi) Inclined Roofs As per IS : 875 (Part-II) vii) Dust load on roof Equivalent to 0.30 M of ash deposit viii) Walkways (General) 0.50 ix) Walkways of conveyor galleries, DM & PT 0.30		
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6.02.03 6.02.04 6.02.05 6.02.06 6.02.07 6.02.08	x) Floor of control room of switchyard control building 1.00 xi) Cable and pipe trestles addition, friction loads 0.40 for walkway and in as applicable Notes: a) If erection load is higher than the specified imposed loads on any floor or part thereof, then the erection loads are to be considered for the design. b) Additional load for cable, piping/ducting, shall be considered as applicable. For any other structures, the loads specified for those structures elsewhere in the specification shall be followed. Equipment, piping and associated loads Equipment loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier. Crane load For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously. Seismic load For design of all structures, the site specific seismic spectrum as attached in Annexure-(e) shall be followed. Wind load For design of all structures, the wind loads shall be taken as per the site specific wind data specified in Annexure-(d) of this specification. Temperature load For temperature loading, the total temperature variation shall be considered as 2/3 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. Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS: 456 for steel and concrete structures respectively. Differential settlement Loads Structures shall be designed considering an additional load on account of differential settlement of 1 in 1000 between any two adjacent columns, subject to a maximum differential		
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6.02.09	settlement of 8 mm. Additional Loads Following Minimum additional Loads shall be considered in the design of Steam generator structures, Mill & bunker buildings, Coal handling Transfer points and Trestles. (a) Cantilever Loads of not less than 2000 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the ESP, for Cable trays and Walkways. (b) Cantilever Loads of not less than 500 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the Steam Generator, for Cable trays and Walkways. (c) Cantilever Loads of not less than 2000 Kg / M at a distance of 2500 mm from the external face of the Mill & Bunker Building columns, CHP transfer point columns/ VGTU columns & conveyor gallery trestles (on one side) for Cable trays and Walkways. (d) Dry Fly Ash Piping Loads. (e) Ash Water Piping Loads. (f) Supply Air and Instrument Air Piping. (g) Service Water Piping (h) Loads associated with Coal Handling Plant equipment		
6.03.00	Civil Design Concepts		
6.03.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.,		
6.03.02	The different load combinations shall be taken as per IS: 875 (Part-5) and other relevant IS Codes. a) Wind and seismic forces shall not be considered to act simultaneously. b) For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall be considered. c) 'Lifted load' of crane shall not be considered during seismic condition. d) In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane. e) In case two cranes are provided and tandem operation is envisaged for some bays, then the load shall be taken as both the cranes fully loaded and travelling side by side for these bays. For other bays, load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane. f) Permissible stresses for different load combinations shall be taken as per relevant IS		
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	and IRS codes. g) For the design of pipe/cable supporting structure, the soil weight shall be considered as backfilled up to grade level for the condition of pipe running full/cables in position. h) Frictional forces between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces. i) Paving in crane corridor shall be designed for the maximum load due to movement of crane. j) In TG bay at crane rail level, chequered plate walkway with handrails shall be provided for entire column sectional depth for full length of the building. Walkway width clearance from the face of the column to the edge of the crane shall be as specified elsewhere in the specification. k) For checking against uplift / tension case, 90% of Dead Loads with no Imposed Loads shall be considered along with other Loads l) In all Loading Combinations, the Loads that have reduction effect on design condition shall not be taken into account in the Combination concerned. m) Where Wind is the main Load acting on the Structure, no increase in Stresses is to be considered for Design of Structures and Foundation Bolts. 6.03.03 Design of steel structures shall be done by the Working stress method. Design shall be as per provisions of IS:800 :1984 and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (part I to III) shall be followed. 6.03.04 Shop connections will be all welded type and field connections shall be either bolted or welded depending on site difficulties. Field bolts wherever provided will be high tensile friction grip bolts of 20 mm dia or higher and of property class 8.8(min) as per 1367 for all major connections. The bolted joints will be designed for friction type connection and H.T. bolts will be tightened to develop the required pretension during their installation. However, nominal connections in the field like purlins, stairs, wall beams will be done by means of M.S. black bolts of grade 4.6 conforming to IS-1367. Following connections will be provided during erection 1. Welded connection a) connection of secondary beam to main beam b) connection of bracing to column c) connection of bracing to the longitudinal beam d) connection of longitudinal tie beam to column e) connection of spandrel beam to column f) connection of their secondary structures 2. HSFG connection a) splicing of column/transverse frame beam/longitudinal tie beam		
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6.03.05	b)	connection of frame beam to column													
	c)	connection of crane girder to column													
	d)	connection between crane girders													
	e)	connection of brackets from columns													
	f)	connection of members where tension will be in the fasteners													
	g)	other major connections													
	3.	Bearing Type connection (H.T. bolts grade 8.8)													
		All removable type connections.													
	4.	M.S. bolts (Grade 4.6) shall be used for purlins, stairs, wall beams etc.													
	For HSS bolt connection, IS: 4000, IS: 3757, IS: 6623 and IS: 6649 shall be followed. IS: 814, IS: 816, IS: 1024, IS: 4353 and IS: 9595 shall be followed for welding of structures.														
	For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force, casual over burden and impact factor, etc. Thus coal load per unit length of each moving conveyor shall be														
	1.6 x (rated capacity of conveyor system) Conveyor speed x 1100 800														
6.03.06	a)	Conveyor gallery structure and trestles shall be designed considering both conveyors operating simultaneously													
	b)	Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25 m.													
	c)	All structures close to railway line shall have clearances conforming to Railway norms.													
	6.03.07	Horizontal Deflection criteria													
	The maximum Horizontal Deflection for various structures shall not exceed and be limited to the following:														
<table><tr><th>Sl. No.</th><th>Description</th><th>Maximum value of</th></tr><tr><td>1.</td><td>For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)</td><td>Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)</td></tr><tr><td>2.</td><td>For Mill & Bunker Building (at Tripper floor level)</td><td>Height/500 (For wind load by Gust Factor Method / Seismic Load)</td></tr><tr><td>3.</td><td>For Main Power House (Turbine Bldg),</td><td>Height /325</td></tr></table>				Sl. No.	Description	Maximum value of	1.	For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)	2.	For Mill & Bunker Building (at Tripper floor level)	Height/500 (For wind load by Gust Factor Method / Seismic Load)	3.	For Main Power House (Turbine Bldg),	Height /325
Sl. No.	Description	Maximum value of													
1.	For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)													
2.	For Mill & Bunker Building (at Tripper floor level)	Height/500 (For wind load by Gust Factor Method / Seismic Load)													
3.	For Main Power House (Turbine Bldg),	Height /325													
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	ESP Control Building, Air Washer Building, Compressor House, Service Building, Workshop Building, Balance of Plant Buildings and all other buildings envisaged in this specification			
	4.	Vertical Metal Sheeting in Cladding	Span/250	
6.03.08	a)	Dispersion of load in any direction through soil shall be as per IS: 8009 (relevant part).		
	b)	Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.		
6.03.09	a)	Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.		
	b)	The allowable deflection for beams directly supporting drive machinery shall be restricted to span/500 unless specified otherwise in this specification.		
	c)	The deflection for manually operated cranes & monorail supporting beams shall not exceed span/500.		
		For electric overhead cranes :		
	1)	upto 50 t capacity : span/750		
	2)	over 50 t capacity : span/1000		
	d)	The vertical deflection of beams supporting LP Heater, HP Heater and Deaerator shall be limited to Span/500.		
	e)	The vertical deflection of metal deck sheet for floor shall be limited to span/250.		
	f)	Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / chequered plates shall be span/250. However, the maximum vertical deflection of Grating/ Chequered plate shall be limited to 6 mm.		
6.03.10	Transverse coal pressure on Bunker/Silo/Hopper walls shall be calculated as per IS: 9178. The Coal Bunker/Silo/Hopper shall be designed for the following conditions			
	i)	The Bunker/Silo/Hopper is full up to its full capacity with top surface nearly horizontal.		
	ii)	The Bunker/Silo/Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.		
6.03.11	Design criteria for ash silo			
	1.	The pressure due to ash filling on the side wall and the bottom portion of ash bins/silos shall be taken as the maximum of (a) static pressure determined in accordance with the Jansen's formula multiplied by an impact factor of 1.4 and (b) pressure determined as per Walker's formula for static as well as dynamic conditions. The silo shall be designed for the following conditions:		
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6.03.12	(a) The silo is full up to its full height / capacity (b) The silo is partially empty with top surface of ash, at an angle of repose less than 30 degrees. 2. The following loads are to be considered for design. a) Density of bottom ash to be considered for volume calculation shall be 650 kg./cu.m. b) Density of bottom ash to be considered for load calculation shall be 1600 kg/cu.m. c) Density of fly ash to be considered for volume calculation shall be 750 kg/cu.m. d) Density of fly ash to be considered for load calculation shall be 1600 kg./cu.m. e) Density of dry fly ash, to be considered for the design of supporting structures for dry fly ash conveying pipes, shall be taken as 1000 kg/cum. The pipe shall be considered full with dry fly ash. 3. Other requirements are as follows: a) Independent supporting structure shall be provided for each silo. b) The joint between the wall and roof of the silo shall be properly sealed by welding or by any other approved means. c) Operating platform covering total plan areawise in silo structure made of grating shall be provided below the hopper outlet. d) The bracing system shall be provided in such a way that the trucks and closed tankers can have a clear passage to approach the underside of the silos for unloading dry ash from the silos. 4. Trestles supporting ash pipes shall be so proportioned that the transverse deflection of trestles due to wind/seismic load shall not exceed trestle height/325. 5. The corrosion allowance for design of Silo, Buffer Hopper, Bottom ash hopper, tanks etc. shall be considered as per IS:9178 considering structure exposed to atmosphere. The corrosion allowance shall be provided in addition to the requirement of minimum thickness of steel plate as per IS:9178. Coal Bunker (inside Mill Bunker Building) shall be of MS while the hopper shall be of MS with stainless steel (grade SS 304) lining. The minimum thickness of MS plate and SS lining in hopper portion shall be as specified in the design concept of Mill Bunker Building in the previous chapter. Pre-formed flexible open ended bellow strap of neoprene is to be provided between top of bunker and bottom of tripper floor to avoid coal dust leakage / escape. The bellow strap shall be of minimum 200 mm wide under un-stretched condition and shall be of minimum 2mm thick. The hopper angle with the horizontal plane be as specified in the previous chapter.		
6.03.13	The live storage capacity of each bunker shall be greater of the following:		
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	a) Total 10 hours coal requirement of the boiler for BMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere. b) Total 10 hours coal requirement of the boiler for BMCR duty with design coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere. c) Total 10 hours coal requirement of the boiler for TMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required to be in service for this duty condition as specified elsewhere. 6.03.14 For all capacity (volume) calculation and structural design (load calculation) unit weight of coal shall be assumed as 800 Kg/cu.m. and 1100 Kg/cu.m respectively. 6.03.15 Design pressure on coal bunker/hopper walls shall take into account all possible flow regimes (core flow, mass flow, etc.), and different aeration regimes (radial, diametrical, radial and core, impulsive, etc). 6.03.16 a) The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification. b) For design and construction of steel-concrete composite members, IS: 11384 shall be followed. c) For reinforcement detailing, IS: 5525 and SP: 34 shall be followed. d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more. 6.03.17 a) All RCC liquid retaining/conveying shall be designed by working stress method as outlined in clause no. 4.5 of IS 3370 (Part-2) 2009 unless specified other wise. b) Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures (requiring dry working condition). Dense and durable concrete with water cement ratio not more than 0.45 shall be used. Plasticiser /super-plasticiser cum water proofing compound shall be added to the concrete. All the construction/expansion joints shall be provided with PVC water bar and chemical injection grouting as per IS:6494. As applicable internal/external surface of such structures shall be provided with acrylic based polymer modified cementitious composite coating system for critical structures. For liquid carrying/retaining structures, minimum two coats of such coating shall be applied. For external application wherever the surface is in contact with the earth, fine silica/quartz sand of 0.6 mm nominal size shall be added in the coating mix for better abrasion resistance and total nominal thickness of such coating shall be minimum 1.5 mm. For non critical structures minimum two coats of bitumen grade 85/25 as per IS:702, mixed with 1% of anti-stripping compound meeting the requirement of IS:6241, shall be applied. The total application of bitumen shall not be less than 1.7 kg/sq.m. Bidder shall submit a comprehensive scheme for water proofing treatment based on above or any other alternative scheme, internationally accepted for Employer's approval prior to commencement of work. c) All liquid retaining/carrying structures shall be tested for water tightness as per the provisions of IS: 3370 and IS: 6494 and in case of leakage, the same shall be		
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	rectified by chemical injection grouting through nozzles.			
6.03.18	For design of all underground structures, foundations, C.W. ducts, etc. ground water table shall be assumed at the finished ground level unless specified otherwise.			
6.03.19	Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest or co-efficient of active earth pressure, whichever is applicable, depending upon the structural configuration. However, for the design of substructure of pump houses, earth pressure at rest shall be considered. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.			
6.03.20	a) Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, trenches and other underground structures containing liquid i) Water pressure from inside and no outside pressure, like earth pressure, ground water and surcharge pressure (applicable only to structures, which are liable to be filled up with water or any other liquid.) ii) Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside. iii) Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves/flap valves, etc., shall not be permitted to counter the buoyancy unless specified otherwise. iv) Base slab and piers of the pump houses shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water level. b) Intermediate dividing pier of pump sumps and partition wall (if applicable) in channel shall be designed considering water on one side only and other side being empty for maintenance. c) All pump houses and other substructures (wherever applicable) shall be checked for stability against sliding and overturning during construction as well as operating conditions for various combinations of loads.			
6.03.21	a) Design of Foundation for TG, TDBFP, MDBFP & Fan foundations (ii) Scope of Work for Bidder The scope of work for the design shall consist of the following: • Finalization of the general arrangement layout and levels of the foundation for TG, TDBFP, MDBFP & FAN foundations based on the equipment layout keeping in view the layout constraint and limitations of available space. • Submission of design criteria and loading data of the equipment foundations. • Analysis of the top deck, design and detailing of the reinforcement and finalization of the spring arrangement.			
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	- Submission of all design calculation, all loading drawings, general arrangement drawings, embedment drawings, spring arrangement drawings and reinforcement drawings for the foundations under the scope for the approval of the Owner. Carrying out revisions / alterations based on the comments of the Owner. In addition to hard copies, the final soft copy of all drawings (in Autocad and pdf format) and documents shall also to be submitted. - Submission of construction methodology / casting sequence and special requirements (if any) for the top of deck. Structural Arrangement of foundations for various machine foundations like TG, TDBFP & MDBFP & FAN and shall be as specified in Chapter-5 of this specification. (iii) Analysis for the foundation For the foundations of the all equipments, details static and dynamic analysis shall be done. The static analysis shall include all operating condition, load cases and abnormal loads like short circuit, loss of blades & unbalance and seismic forces as per IS:1893. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. A minimum fatigue factor of 2.0 shall be considered for dynamic forces. The vibration amplitudes shall be calculated at the machine bearing locations and at any other points of interest by a forced response analysis. The unbalance forces used for this analysis shall correspond to the balance quality grade of the machine as per VDI 2060 or the unbalance forces as provided by the machine manufacturer which ever is higher. It shall be ensured that the calculated amplitudes do not exceed the limits specified by the machine manufacturer and relevant Standards such as VDI 2056. Bidder to consider the acceleration at the top of the deck for the design of supporting / fixing arrangement of machine. (iv) Design criteria for steel helical springs and viscous dampers The isolation efficiency for steel helical springs and viscous dampers shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall not exceed 0.80. At least 3% to 5% of critical damping shall be provided in the form of viscous dampers. (v) Grade of Concrete and reinforcement Grade of concrete for Top deck shall be minimum M35 conforming to IS:456-2000. The grade of reinforcement for Top deck shall be Fe500 (TMT) conforming to IS:1786. (vi) Reinforcement Design Working stress method as per IS: 456-2000 shall be used for reinforcement design. The design shall be done for the worst load combination. Minimum reinforcement shall be provided as per IS:456-2000 and IS:2974 (Part-III), if the calculated reinforcement is less than the minimum. Block Foundations: a) Block foundation resting on soil shall be analyzed using elastic half space theory. In case the foundation is supported over piles, Novak's approximation shall be used for determining the spring constant and damping ratio of pile groups. The mass of the		
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	RCC block shall be at least three times the mass of machine. Free vibration analysis of the foundation shall be carried out to evaluate the natural frequencies. The fundamental natural frequency shall be kept at least 20% away from the operating frequency (speed). Forced vibration analysis shall be carried out if the dynamic forces are made available by the machine supplier in which case the amplitude limits stipulated by the machine supplier and VDI 2056, whichever is lower, shall be satisfied. Reinforcement design shall be done by working stress method as per IS:456-2000 and IS:2974 (Part-IV).			
6.03.22	b)	For the foundations supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably. If RCC floor/roof is assumed to act as diaphragm, transmitting lateral loads to braced bays, it shall be provided with shear connectors. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.		
6.03.23		All roads shall be rigid pavements specified elsewhere in this specification. The design traffic load shall be a minimum 4 million cumulative standard axle. The design of concrete pavement shall be carried out as per IRC-58.		
6.03.24	a)	No cable/pipe trench is envisaged in the plant area. However, if required, pipe/cable trench can be provided inside the buildings and inside switchyard or some other localised areas.		
	b)	All pipes and cable shall generally be routed above ground.		
	c)	A minimum clearance (clear headroom) of 8 m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 600mm width with hand-rails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, upto the pipe/cable racks/trestles.		
	d)	Within AB bay in Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.		
6.03.25		The plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, intensity of rainfall, etc., The storm water drainage shall cater to storm water run off resulting from one hour rainfall intensity, with a return period of 50 years. These values shall be based on the "Detailed Area Drainage Study" subject to minimum rainfall intensity of 75mm/hr. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. RC box culverts shall be provided at rail, road or		
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6.03.26 6.03.27 6.03.28 6.03.29 6.03.30 6.03.31 6.03.32	other crossings. Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec. Manual on sewerage and sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose. Roof decking sheets shall be designed as per IS: 801 to carry the self load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per BS: 5950. In case composite action is considered in the design, suitable shear studs shall be provided as per BS: 5950. Foundations for all tanks shall be designed for as per IS: 803. Footings shall be so proportioned to as to minimise the differential settlement. Boiler/ ESP support structures shall be designed for: i) Live/Imposed loads. ii) Dead load iii) Static and dynamic loads of piping, movable equipment and maintenance parts. iv) Loads from cable trays and walkways supported on columns. v) Ash water piping supported on the outermost row of boiler columns. vi) All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of electrodes (whichever is more) using a bulk density of not less than 1350 kg/cu.m. for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case). vii) Ash load at bottom ash hopper and pent house of the boiler shall be as mentioned in the mechanical chapter of the specifications. viii) Seismic and wind loads as specified elsewhere in the specifications. ix) Temperature variation of +/-25°C for atmospheric temperature variations. x) Temperature variations under ESP operating condition. xi) The loads listed above indicate the minimum requirements. Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 °C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0 m. The exact levels shall, however, be decided during detailed engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground. The bracings in boiler structure shall be provided such that under no circumstance normal/convenient access to all points in the boiler is blocked or obstructed.		
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6.03.33	In design of boiler/ ESP support structures, dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.			
6.03.34	Design Criteria for foundations and some other facilities/areas are covered separately in this specification.			
6.03.35	Plinth level of all buildings shall be kept at least 500 mm above the finished grade/formation level.			
	Finished floor level of boiler area paving shall be kept about 200 mm lower than the finished floor level of Main Plant buildings.			
6.03.36	Joints/Connections in steel structures:			
	Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:816, IS:9595, IS:1367, and IS:9178 and as per following requirements.			
	a) Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.			
	b) Size of fillet weld for flange to web connection for built up section shall be as follows:			
	i) For box section weld size shall be designed for full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.			
	ii) For built up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated, in drawings) whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be double fillet.			
	iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.			
	c) Shear connections shall be designed for 60% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.			
	d) Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section. This can achieved either by direct butt welding of the top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length.			
	e) All butt welds shall be full penetration butt welds.			
	f) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Engineer.			
	g) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum			
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	weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.			
	h) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. In exceptional cases, the field splicing shall be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.			
6.03.37	Pipe Pedestals, pipe supports and other structures for Ash handling/ash water recirculation system: a) The design of Pipe Pedestal and pipe supports shall be carried out considering Dead load, live load & seismic load / wind load. In addition to above, longitudinal forces equal to product of Co - efficient of friction (between contact surface of pipe and pedestal) with the load coming on each pedestal shall also be considered for the design of pedestal. In bends, suitable thrust block shall be provided to withstand the thrusts transferred from the pipelines. b) All RCC pipes carrying water under gravity shall be designed for earth pressure, water and surcharge. Minimum grade of pipe shall be of NP - 2 class or heavier required as per design / specification. c) The design and construction of RCC structures shall be carried out as per IS: 456. In general, limit state theory shall be followed for the design of RCC structures, however, working stress method shall be adopted for the design, wherever specifically mentioned in this specification. d) Two layers of reinforcement (on inner and outer face) shall be provided for RCC wall sections having thickness 150mm and above.			
6.03.38	Design Criteria of RCC Floors a) For Main Power House, Mill Bunker Building, ESP Control Building, Transfer Houses of CHP, Air Washer Building and other structural steel framed buildings: These buildings being steel framed structure, all RCC floors shall comprise RCC slab supported on troughed, profiled metal deck sheet of minimum thickness 0.80mm (to be used as permanent shuttering). The RCC slab shall be minimum 150mm thick above the top surface (crest) of the metal deck sheet. The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self weight of green concrete and additional construction load of 100 kg/m2. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design). (b) For Administrative Building, Service Building, CISF building & other RCC buildings.			
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6.03.39	These buildings being complete RCC framed structures, conventional RCC slabs of minimum thickness 125mm shall be provided. The RCC slabs shall be monolithic with RCC beams and RCC columns Design Criteria of RCC roofs: a) For Main Power House, Compressor House, Air Washer Building, ESP Control Building: The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification). The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design. b) For Mill Bunker Building, Transfer Houses. Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification. c) Other RCC Buildings. Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).			
6.03.40	Design Criteria For Foundation The founding depth / cut off level of piles shall be decided based on functional requirement. Where structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving except for Main power House Building columns, Boiler Structure, Bunker Building Columns, TP & Trestle Columns, ESP Control Building Columns for which the requirement of levels for bottom of base plates is specified elsewhere in this specification. Further the gusset plate and foundation bolts are to be encased in concrete up to the top of the paving level. For outdoor structural steel columns, about 300 mm height of steel columns above the top of paving level shall be provided with at lease 125 mm thick encasement with minimum reinforcement to prevent corrosion of the steel columns from surface water a) OPEN Foundations For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification. For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.			
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6.03.41	The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456. No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC of grade M7.5. b) PILE Foundations Minimum centre to centre spacing of the piles shall be 3 times the diameter of pile. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other. Minimum penetration of piles into Pilecap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face of pile cap shall be same as that stipulated for beam as per IS:456. Detailed requirement of pile foundation have been presented in the foundation chapter specified hereafter in this specification.			
	Coal Handling Plant structures a) The loads for all railway load bearing structures e. g. track hopper including machinery hatches, tunnel, culverts and under ground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up .to the date of opening of bids. However, the axle load for analysis and design shall be considered as 30 MT. Coal heap of 1.2m height shall be considered above hopper top for design of coal tray, hopper and supporting elements of track hopper. The analysis, design and detailed drawing for the structure coming below the railway track shall be got approved by the Bidder from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority. b) The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles. c) Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory d) Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. e) The buildings shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41. f) Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.			
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	g) Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement. h) For design of R. C. C. pipes for culverts, latest editions of IS : 458, IS : 783 should be followed. i) Design of masonry walls shall be made as per IS : 1905. j) Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcement is required as per design.			
6.04.00	Corrosion Protection			
6.04.01	General			
	(a) All equipments, pipes, etc. shall be painted as per the requirements specified in the relevant section of the specification. (b) All Steel structures (except those embedded in Concrete) shall be provided with Painting as given below which is designed for a minimum maintenance free life of Ten (10) years (expected life, long range Ten (10) to Twenty (20) years, as per BS : 5493. (c) All Paints shall be of high build constitution. (d) All Painting shall be done as per approved Painting scheme of the Vendors / Manufacturers, which shall be submitted by the Bidder and as approved by the Employer. Painting scheme shall also include Item codification / Description of all Coats of Paints for manufacturer's, from whom the Paint is intended to be procured.			
6.04.02	Painting of Steel Surfaces embedded in Concrete:			
	(a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT). (b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.			
6.04.03	Painting of Steel Surfaces (other than those embedded in Concrete)			
	(a) All Steel surfaces shall be provided with self curing Inorganic Zinc Silicate Primer Coat (Solid by Volume Minimum 60%) of Minimum 75 Micron Dry Film Thickness (DFT) applied over shot blast cleaned surface to near white metal conforming to Sa 2 ½ finish of Swedish standard SIS-05-5900. The Primer Coat shall be applied in Shop immediately after blast cleaning by Airless spray technique. (b) Primer Coat shall be followed with the application of Intermediate Coat of Polyamide Cured pigmented Titanium Dioxide (TiO2) or Micaceous Iron Oxide (MIO) Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied in Shop after an interval of Minimum overnight (from the application of Primer Coat) by Airless spray technique.			
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6.04.04	(c)	Intermediate Coat shall be followed with the application of Finish Coat of Polyamide Cured colour pigmented Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied after an interval of Minimum overnight and maximum indefinite (from the application of Intermediate Coat) either before Erection by Airless spray technique or after Erection by brush and / or airless spray. Colour and shade of the Coat shall be as approved by the Employer.		
	(d)	Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented Paint (Solid by Volume Minimum 40%) of Minimum 25 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat), after Erection by brush and / or airless spray. Colour and shade of the Coat shall be as approved by the Employer.		
	Touch-up Painting on damaged areas			
	(a)	For Coatings damaged up to metal surface Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer. Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within maximum seven (7) days of application of touch up Primer.		
6.04.05	(b)	For Coatings damaged upto Intermediate Coatings (i.e. where Primer Coat is intact). Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat. Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.		
	Painting of Welded areas / Painting of areas exposed after removal of temporary supports / Touch-up Painting on damaged areas Structures, where inter-connection, Welding / modification etc. has been carried out by the Bidder.			
6.04.06	(a)	Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.		
	(b)	Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.		
6.04.07	Dry film thickness of each coat shall be checked and measured as per the procedure specified in paint application standard no. 2 by SSPC: The Society for Protective Coating. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of technical specification.			
6.04.08	Coating for Mild Steel parts in contact with Water.			
6.04.09	(a)	All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 Gms / Sq. M. for galvanised Structures and shall comply with IS : 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS : 2629.		
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6.04.08 6.04.09 6.04.10 6.04.11 6.04.12	(b) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS : 3416, unless otherwise specified. Gratings All gratings shall be blast cleaned to Sa 2 ½ finish of Swedish standard SIS-05-5900 and shall be hot dip galvanised at the rate of 610 Gms / Sq. M. Hand Railings and Ladders All handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. as per IS : 4736. Sea Worthiness All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti corrosive Paint before shipment to take care of sea worthiness. All structural steel members in switchyard (excluding fencing and gate) shall be hot dip galvanised as specified elsewhere. For reinforced concrete work. i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts. ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion. This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc., Bidder shall furnish the details of corrosion protection measures.		
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7.00.0 7.01.0 7.01.02 7.01.03 7.01.04 7.02.00 7.02.01	FOUNDATION SYSTEM SOIL DATA AND GEOTECHNICAL INVESTIGATION Soil Data Owner has carried out preliminary geotechnical investigation in the plant area, pipe line corridor from plant to intake well including crossings (river/ nallah/ canal/ road/ railway track etc.) and intake well location of project site and the borelog are enclosed at Annexure-c for Bidder's reference. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. Contractor shall carry out detailed geotechnical investigation for structures under his scope as per scheme given at Annexure-I The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundations and allowable bearing pressure/pile capacity for various structures/facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundations. Tank Foundations a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil. b) Entire expansive soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III. c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers etc to achieve a relative density of not less than 80%. d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications. Foundation System The requirements for the foundation system to be adopted are as given in subsequent clauses. General Requirements a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations. b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drain and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil. If the encountered sub-strata is black cotton soil, the same shall be			
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7.02.02	either replaced upto the full depth or black cotton soil shall be stabilized by suitable treatment. c) No other foundation shall rest on the filled up ground / soil. d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level. e) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building. f) Foundation for equipments on ground floor For equipments of static weight upto 1.5T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab may be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 5T/m². Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications. For equipment of static weight more than 1.5T, the equipment foundation shall be taken to below the Natural Ground Level (NGL) or built up with PCC upto the specified level as per functional requirement. The equipment foundation shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment foundation for the full depth of the floor slab. However, in no case, the foundation depth shall be less than 1.0 m.		
	Open Foundations In case open foundations are adopted, following shall be adhered to. a) The minimum width of foundation shall be 1.0 m. b) Minimum depth of foundation shall be 1.0m below Ground Level. c) It shall be ensured that all foundations of a particular structure/ buildings facility shall rest on one bearing stratum. d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC up to designed foundation level. e) No foundation shall rest in black cotton soil. f) During design the Allowable Bearing Pressure shall be adopted after approval of detailed geotechnical investigation report. However, the maximum allowable bearing		
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pressure shall be as per approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m ²	
	Isolated and combined footings width upto 6.0 m	Rafts (width > 6m)
1m below NGL in Silty Sand / Sandy Silty Clay	8.0	10.0
2m below NGL in Silty Sand / Sandy Silty Clay	12.0	15.0
0.30m Embedment in silty sand with boulders/completely weathered rock.	25.0	25.0
0.60m Embedment in silty sand with boulders/completely weathered rock.	35.0	35.0
1.00m Embedment in rock with core recovery > 20%.	45.0	45.0
1.20m Embedment in rock with core recovery > 20%.	55.0	55.0

In case any loose/soft pockets in rocky strata is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

- g) For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (BTG Area Footings except ESP Footings)	25 mm
Isolated & Strip (Other than BTG Area)	40 mm

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7.02.03	<table><tr><td>Raft (ESP Foundations and other Offsite Structures footings)</td><td>75 mm</td></tr><tr><td>Foundations in Weathered rock / rock</td><td>12 mm</td></tr></table>		Raft (ESP Foundations and other Offsite Structures footings)	75 mm	Foundations in Weathered rock / rock	12 mm										
	Raft (ESP Foundations and other Offsite Structures footings)	75 mm														
	Foundations in Weathered rock / rock	12 mm														
	Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.															
	Pile Foundations –															
	In case piles are adopted, following shall be adhered to :															
	i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.															
	The piling work in river/water body shall be carried out with temporary or permanent MS liner and approved construction methodology. If piles are extending, above bed level of river/water body, in water, permanent MS liner of minimum 8mm thickness shall be provided.															
	ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:															
	<table><tr><td>Pile</td><td>Dia. (mm)</td><td>Vertical compression capacity (T)</td></tr><tr><td rowspan="4">Bored cast-in-situ pile</td><td>600</td><td>140</td></tr><tr><td>760</td><td>250</td></tr><tr><td>1000</td><td>310</td></tr><tr><td>1200</td><td>375</td></tr></table>			Pile	Dia. (mm)	Vertical compression capacity (T)	Bored cast-in-situ pile	600	140	760	250	1000	310	1200	375	
Pile	Dia. (mm)	Vertical compression capacity (T)														
Bored cast-in-situ pile	600	140														
	760	250														
	1000	310														
	1200	375														
Cut Off Level (COL) is considered as 3.0 m below Finished Ground Level (FGL)																
Termination criteria of piles shall be as per the approved geotechnical investigation report.																
The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.																
However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.																
iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.																
iv) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, locations of initial test piles etc.) for Engineer's approval.																
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	v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval. vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under. Vertical Lateral Minimum of 2 Nos. in each mode. Uplift vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part). viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter. ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under : i) Vertical : 0.5% of the total number of piles provided. ii) Lateral : 0.5% of the total number of piles provided. x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer. xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required. xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm. xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge.		
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	xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM. xv) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions. xvi) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles. xvii) Reinforcement for job piles shall be designed for the allowable safe pile capacities with combinations i.e. compression+bending case or tension+bending case, irrespective of the actual load on each job pile.											
7.03.00	Special Requirements											
7.03.01	Chemicals in subsoil, as observed during preliminary geotechnical investigation are: <table><tr><th>Chemical</th><th>SO₃ (%)</th><th>Chlorides</th><th>pH</th></tr><tr><td>Sub-soil</td><td>0.0091-0.0880</td><td>0.022-0.040</td><td>6.75-7.03</td></tr></table> The above values are for information, however, details of treatment for foundations / underground structures required to counteract soil / water chemical environment, cement type, grade of concrete, type of reinforcement, cover to reinforcement and protective coating to foundations, etc. shall be as per detailed geotechnical investigation to be carried out by bidder. Bidder shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.				Chemical	SO ₃ (%)	Chlorides	pH	Sub-soil	0.0091-0.0880	0.022-0.040	6.75-7.03
Chemical	SO ₃ (%)	Chlorides	pH									
Sub-soil	0.0091-0.0880	0.022-0.040	6.75-7.03									
7.04.00	Excavation, Filling and Dewatering											
7.04.01	For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth .											
7.04.02	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M 7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.											
7.04.03	Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each											
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	layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non cohesive soils. In any case, black cotton soil shall not be used in back filling without providing cushion of 1m of non expansive cohesive soil/moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.4m moorum shall be provided.			
7.04.04	The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.			
7.04.05	CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.			
7.05.00	Sheeting & Shoring The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation, executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.			
7.06.00	Special requirements for river side/submergence facilities Bidder may provide suitable foundations as per IRC. The design of river/water body side foundations shall account for local scour around foundations, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC. During design the Allowable Bearing Pressure/pile capacity shall be adopted after approval of detailed geotechnical investigation report. A) Bridge/ Approach bridge piles (Incase pile foundations are to be adopted) i) The design of river/water body side piles shall account for local scour around pile, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC. ii) Contribution of frictional resistance from bed level upto maximum scour depth shall not be considered for computation of frictional resistance of river/water body side piles. iii) All piles shall be located using Total Station Laser Operated Instrument. iv) Initial pile load test under vertical (compression) & lateral loads shall be conducted on initial test piles installed river/water body side. If it is not feasible, initial load tests in simulated conditions (removal of skin friction from pile cut of level to the river bed level) may be conducted on river/water body bank with the approval of the Engineer. v) All the river/water body work safety norms shall be adhered to. vi) Diameter of piles for bridge/ approach bridges shall be 1200mm. The vertical capacity, uplift & lateral load carrying capacity shall be as per clause no. 7.02.03.			
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7.07.00 7.07.00.00 7.07.01.00 7.07.02.01 7.07.02.02 7.07.02.03 7.07.02.04	B) For Intake well The termination of river intake well shall be decided based on the following criterion : a) Depth of sinking of well into soil/rock shall be as per IRC-78 considering, scour depth, overall long term safety and stability of intake well. b) In case of well foundation (caissons resting on rock), the stipulations of IRC:78 shall be compiled to. <u>ANNEXURE-I</u> Geotechnical Investigation The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work. Scheme of geotechnical Investigation Field test shall include but not be limited to the following: Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT) , Electrical Resistivity Test (ERT), Seismic Refraction Test (SRT) or Cross Hole Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc. The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. The minimum tests are indicated in Appendix A. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers. Laboratory Tests on Soil Samples Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell		
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	1	Main Plant structures (Transformer Yard, Main power house, Boiler, ESP, Chimney, Mills, Fans etc)	40 to 50 m along the rows of main power house columns. Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 3 boreholes under Chimney, Minimum 2 boreholes under each TG, ESP Control Room, TPs. 4 boreholes in Transformer yard	Depth of boreholes shall be 25m to 30m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.
	2	Switch yard area	Minimum 6 no of boreholes	15 to 20 m	
	3	Water Treatment plant area	Minimum 5 no of boreholes	20 to 25m	
	4	Cooling towers	Minimum 3 boreholes under each cooling tower	20 to 25 m	
	5	CW Pump House Area	Minimum 3 boreholes	15 to 20 m	
	6	Coal handling area	Minimum one borehole under each TP and one under each crusher house. 2 boreholes under track hopper and wagon tippler and one borehole under each structure. Minimum 3 Nos. of boreholes in each Coal Stock Pile area.	25 to 30 m	
	7	Raw Water Reservoir Area	Minimum 5 boreholes	10 to 15 m	
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	8	Ash Handling Structures	Minimum 5 boreholes	20 to 25 m	
	9	Corridors for Ash pipe routes	One borehole @ 750 m c/c along the identified corridor	10 m	
	10	Crossings along the pipeline corridor like road, river, nallah/ canal	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10.0m	Depth of borehole shall be 25m	
	11	Transmission line from Plant to Intake Pump House	One borehole @ 750 m c/c along the identified corridor	10 to 15 m	
	12	Other Off site Structure/Facility	Minimum Two boreholes under each area / facility	20 to 25 m	
	b) Other Field Tests (Minimum)				
	1	Plate Load Test (PLT)	1 no each in ESP, transformer yard area and other area, where open foundations are feasible.	Test Depth from 3 to 4 m	
	2	Cyclic Plate Load Test (CPLT)	1 no in each TG, Mill and ID fans	Test Depth from 2.5 to 4 m	
	3	Trial Pit (TP)	About 20 Nos.	Depth - 4 m	
	4	In Situ Permeability Test In Boreholes	In minimum 10 Nos. of boreholes in plant, 4 Nos. of boreholes in Raw Waster Reservoir and 8 Nos. of boreholes in ash disposal area	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
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	5	DCPT	About 10-20% of boreholes up to refusal depth								
	6	ERT	2 Nos. each in Transformer yard, TG, Boiler, Chimney, water treatment plant area, ESP Control Room, 6 Nos. in switchyard, CHP area 1No near each Pump House other than mentioned above								
	7	SRT	In Grid covering the Main Power Block from Chimney to Transformer Yard (about 2000 to 2200 m)								
	8	PMT	50 no of tests in main power house area covering power house to to chimney, TP/Crusher Houses.	Depths covering from 1.0 m to 20.0 m							
	Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, SRT, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.										
	Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried										
	ii) At Intake location in river/water body and make up water pipe line corridor										
	<table><tr><th>S.No</th><th>Structure</th><th>Tests</th></tr><tr><td>1</td><td>Intake well (river side / water body)</td><td>Three boreholes along periphery and One borehole at centre of the Intake well Depth of borehole shall be</td></tr></table>					S.No	Structure	Tests	1	Intake well (river side / water body)	Three boreholes along periphery and One borehole at centre of the Intake well Depth of borehole shall be
	S.No	Structure	Tests								
	1	Intake well (river side / water body)	Three boreholes along periphery and One borehole at centre of the Intake well Depth of borehole shall be								
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				i) 1.5 times the dia / width of intake well below the founding depth of intake well. ii) 5 m into rock with RQD ≥ 50% continuously Whichever above occurs earlier.
		2	Bridge/ Approach bridge (river side / water body)	One borehole at 100 - 150m c/c distance along proposed approach bridge / walkway or at each pier location. Depth of borehole shall be i) 50 m below river bed level ii) 5 m into rock with RQD ≥ 50% continuously Whichever above occurs earlier.
		3	Control room building, swgr room etc. (river bank/ water body)	Three boreholes, two ERT and one PLT Depth of borehole shall be 30m or 5 m into rock with RQD ≥ 50% continuously, whichever occurs earlier.
		4	Approach road to make-up water facilities from nearby existing road and road all round the make-up water facilities within land acquisition boundary and approach to various buildings.	Field CBR test (California Bearing Ratio) at 750m c/c
		5	Bank protection works	Two boreholes along the bank. Depth of borehole shall be 10m Disturbed samples shall be collected at atleast five locations along the bank, from the surface of the bank to the river bed at 3 metre depth interval.
		6	Makeup water pipeline corridor	Boreholes of 10 m depth shall be carried out along the corridor @ 750m c/c and one ERT shall
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			be conducted near to each borehole		
	7	Crossings along the pipeline corridor like road, river, nallah	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10m Depth of borehole shall be 25m or 5 m into rock with RQD ≥ 50% continuously, whichever occurs earlier.		
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8.00.00	GENERAL SPECIFICATION			
8.01.01	Joints in Concrete Structures Construction Joints All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force. Expansions Joints In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS: 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS:12118 or silicon sealing compound shall be used. IS:3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.			
8.01.02	All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti corrosive paint before shipment to take care of sea worthiness.			
8.01.03	A screed or concrete layer not less than 100 mm thick and of grade not weaker than M 10 conforming to IS: 456 shall be provided below all water retaining structures.			
8.01.04	Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.			
8.01.05	Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.			
8.01.06	Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.			
8.01.07	Angles 75 x 75 x 6 mm (minimum) with 8mm dia and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.			
8.01.08	Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.			
8.01.09	Anti termite chemical treatment shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS: 6313 and other relevant Indian Standards.			
8.01.10	Trenches located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. The precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers. The trenches shall be given a slope of 1 in 250 in the direction perpendicular to the			
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	run of the trenches. PVC water stops shall be provided at all expansion joints of all trenches. Trench covers near entry or at road crossings shall be designed for 10 T wheel load at centre. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers.			
8.01.11	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.			
8.01.12	Duct banks consisting of PVC conduits conforming to IS:4998 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.			
8.01.13	Independent network of lines for sewerage and drainage shall be provided.			
8.01.14	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)			
8.01.15	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS: 9758 shall be followed as general guidance for dewatering.			
8.01.16	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level. These shall be encased by concrete cover upto floor level with concrete grade M 30.			
8.01.17	Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/mm² at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.			
8.01.18	Fencing for fuel oil area, switchyard, and transformer yard area shall be of the same type as specified, elsewhere in this specification.			
8.01.19	Plant effluent shall not be mixed with either storm water or sewage.			
8.01.20	Rail-track in transformer yard area shall be provided with rigid type RCC foundation. Rail weighing 52 kg/m shall be used.			
8.01.21	All building shall be design to take care of Rain Water harvesting & ground water recharging.			
8.01.22	Ground Floor Slab & Area / Pathway Paving: For Ground floor / Area paving or path - way having earthen sub-grade, the paving work shall consist of following parts i.e. 150 mm thick RCC M - 25 Grade base slab, 75 mm thick PCC (1:4:8), 275 mm thick (compacted thickness) stone / rubble soling sub base with 63 mm down aggregate compacted to 85% of original volume and interstices filled with well graded selected sand on compacted and dressed sub - grade. Reinforcement of the RCC slab shall consists of minimum 8mm dia bars @ 200 mm c / c at top in both directions.			
8.01.23	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.			
8.01.24	All foundation embedments, inserts, blockouts required for mounting of equipments and supporting any other facility like pipes etc. shall be provided.			
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8.01.25	Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flowable grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30.			
8.01.26	All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays.			
8.01.27	All internal cable trenches shall have minimum 6mm thick (o / p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer.			
8.01.28	All foundations and surfaces of substructures coming in contact with earth shall be applied with three coats of hot applied industrial bitumen conforming to IS : 702 (latest), of Grade 85 / 25, at the rate 1.7 Kg / Sq.m / coat.			
8.01.29	All the liquid retaining structures shall be tested for water tightness with full water level in accordance with IS : 3370 (Part - I).			
8.01.30	All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.			
8.01.31	Base slab of large tanks may be cast in number of panels viz. I, II, III etc. Starting with I, the slab panels shall be cast alternately in chess board fashion, with proper construction joints. Adjacent panels shall be cast with sufficient time interval, so that first cast concrete would have undergone most of its shrinking before the second cast concrete is poured against it. The construction joints shall be provided with chemical injection grouting treatment. The construction joints shall have continuity of reinforcement and shall be provided with suitably keys. The size of panels shall be as per IS : 3370 recommendations.			
8.01.32	For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small possible and the wall should be built to its full height in the least possible time.			
8.01.33	1000mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.			
8.01.34	All masonry walls shall be provided with Damp Proof Course at plinth level.			
8.01.35	Wherever required PVC coated chain - link fencing shall be provided as per specification.			
8.01.36	Expansion joints for all underground structures shall be made water tight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively. Two - part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.			
8.01.37	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.			
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8.01.38	a) All drains inside the building shall have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. b) All drains outside building shall have perforated precast RCC covers of minimum 50mm thickness with provision of openable steel grating cover at about 4.0m interval. In areas where vehicular loads would be coming precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided.			
8.01.39	Hand rail height , size and material to be adopted shall be as per general architectural specification.			
8.01.40	In all buildings, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting etc. shall be provided for each floor with suitable floor drains.			
8.01.41	All cable & pipe routing in outlying area shall be clubbed and shall run over ground on steel trestles or other supporting structures at a height specified elsewhere in this specification except in some localised area (as approved by Employer) where the same can run in trenches. In case cable route is not envisaged in the area, pipe shall be routed on ground over RCC pedestals at a height of not less than 500 mm. All trenches shall be of RCC with removable RCC covers.			
8.01.42	Water supply line & drainage of pump house shall be connected with the nearest Employer's water supply & drainage line.			
8.01.43	Unless specified all sand filling shall be compacted to minimum 75% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC. However, sub - grade for the roads shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC).			
8.01.44	All liquid retaining structures shall be leak-proof. Water proofing of all liquid retaining structures shall be done by addition of plastciser cum water proofing admixture conforming to IS : 9103, in the concrete at the time of mixing and through external treatment by chemical injection grouting at all construction joints as described in the specification. Addition of admixture should not reduce the strength of the concrete below the specified strength in any case. In addition, limit on permeability as given in IS : 2645 shall also be met with. Further if required, chemical injection grouting treatment shall be applied to make the structure leak proof, if leakage is observed during hydro - test or otherwise, with no cost implication to the Employer.			
8.01.45	Plywood formwork shall be used for all water retaining/ conveying structures (only on the face having contact with water) and for all overground concrete works. It shall also be used for the inner face of sump of pump (i.e. faces of piers back walls, breast walls and baffle walls having contact with water. For all other areas steel/ plywood formwork shall be used.			
8.01.46	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area.			
8.01.47	Under drainage arrangement for under ground structures shall be provided as applicable in line with relevant codal provisions.			
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8.01.48	2.0m wide walkway with concrete paving shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL.			
8.01.49	For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).			
8.01.50	Acid/ Alkali Resistant Lining The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.			
8.01.51	Bituminous Coating Bituminous coating shall be applied on the inside faces of the water retaining structures and also on that portion of water retaining structure which are in contact with ground water. Surface to be treated shall be absolutely dry, clean and dust free. The surface shall be sand papered, before applying the coating. The external surfaces of concrete which are in contact with ground water shall be applied with hot industrial bitumen conforming to IS : 702, of grade 85 / 25. The rate of application shall not be less than 1.70 Kg / sq.m / coat, in three coats and it should be heated to about 120°C before application. Anti stripping compound shall be added wherever necessary. After application of third 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 sand, before back filling is done in order to allow the final coat to dry up completely. The internal surfaces of water retaining structure which are in contact with water shall be applied with two coats of bitumen paint conforming to IS : 9862, at the rate of 1.5 Kg / Sq. M. in first coat and 1.0 Kg / Sq. M. in second coat.			
8.01.52	40mm Dia. MS rods as earthing mat, placed at a distance of 1.0M away and at depths between 0.60M and 1.00M shall be supplied and laid all around the periphery of buildings, structures, and out door equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers of structures and equipment. The contractor also supply and lay necessary number of 3.0 M deep 40 mm Dia. MS rods Earthing electrodes and connecting them to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately of two locations.			
8.02.00	Concrete General a) Concrete work shall be carried out as per IS:456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS:10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.			
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	b)	Minimum grade of reinforced cement concrete for all foundations including piling shall be M25 unless noted otherwise. Minimum grade of concrete for other structures/areas (other than machine foundations) shall be M25 for all superstructure and substructure unless noted otherwise elsewhere in this specification.			
	c)	The minimum grades of concrete for different machine foundations and some of other important structural members shall be as follows:			
		Sl. No.	Description	Minimum grade of concrete	
		i)	TG Top Deck	M-35	
		ii)	ID, FD and PA fan Deck	M-30	
		iii)	Coal Mill Deck	M-30	
		iv)	Sub structure supporting top decks of TG, ID/FD/PA Fans, Mills including raft/ footings	M-35	
		v)	BFP foundations including deck	M-35	
	d)	Higher grade of concrete than specified above may be used at the discretion of the Bidder.			
	e)	Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.			
	f)	For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.			
	g)	All underground concrete structures like trenches, substructures of pump houses, all water retaining / carrying structures , etc., shall have super-plasticizer cum water proofing cement additive conforming to IS:9103. In addition, limit on permeability as given in IS:2645 shall also be met with.			
	h)	Minimum grade of concrete for Plain Cement Concrete (PCC) has been specified in the preceding section			
	Special requirements for concreting of major equipment foundations shall be as given below.				
	a)	Coarse Aggregates			
	Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases, high percentage of reactive silica content, aggregate may be allowed where low alkali content cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations). However, in case other types of suitable aggregate is not available, the Engineer may allow the use of lime stone aggregate provided the Bidder gets the sample tested from a reputed testing laboratory for satisfactory performance under high temperature and repeated temperature cycle.				
	Unless otherwise specifically approved by the engineer, the tests shall be carried out				
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	for a temperature range from 10 °C to 65 °C and for 60 (sixty) temperature cycles. b) Temperature Control of Concrete The temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C in the top decks of machine foundations, crushed ice shall be used in mixing water. c) Admixture Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-ratarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below: Top decks of TG, - 150 mm to 200 mm BFP, ID/PA/FD Fans, Mill deck - 100 mm to 150 mm Block foundation - 100 mm to 150 mm Column - 100 mm to 150 mm d) Form work Plywood with film face form work shall be used for the top decks of all machine foundations and also for columns of TG foundation. e) Placing of Concrete Base Raft and top deck of machine foundations shall be cast in a single pour. f) Ultrasonic Testing Ultrasonic pulse velocity test shall be carried out for the top decks of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cu.m. of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS:13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc., g) Scheme for Concreting Weigh Batching Plants, transit mixer, concrete pump shall be mobilised. Arrangements for standby Plant and Equipment shall also be made. h) Reinforcement Steel Reinforcement Steel shall be of grade Fe500 TMT conforming to IS1786. However minimum elongation shall be 14.5%.			
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8.03.0	Formwork Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types. Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only) Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness of 0.80mm. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification. The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet. The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet. Type 2 Formwork: (For RCC Buildings) Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings			
8.04.00	Fencing and Gate Fencing Fencing with gate shall be provided around transformer yard, switchyard area, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications. The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm. The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip 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 a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners. All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.			
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8.05.00	All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer. Toe walls either of brick masonry with bricks of minimum 50 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings. Gate along fencing All gates shall be of structural steel of minimum 3.75 metres width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m. The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS:513. The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.			
	8.06.00	Grating All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm for indoor installation and 32 mm for outdoor installation. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting.		
		Fabrication The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld. Welding a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant. b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting		
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	flange with web) and longitudinal / transverse butt joints for fabrication of columns, framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding. c) Wherever welding is done for assembling the components of structures, the job shall so positioned that downhand welding is possible. d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded. e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny. f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly. g) The members to be jointed by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation. Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded. Electrodes a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm. b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 250⁰C - 300⁰ C for one hour and later on cooled in the same oven to 100⁰C. It shall be transferred to an holding oven maintained at 60⁰C - 70⁰C. The electrodes shall be drawn from this oven for use. c) Where coated electrodes are used they shall meet the requirements of IS:814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage. d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing e) Where bare electrodes are used, these shall correspond to specification of the		
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	parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 Class of AWSA-5-17-69 and IS:3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated. f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively. g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started. Preheating inter-pass temperature and post weld heat treatment. a) Mild steel plates conforming to IS:2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I. However, higher preheat and interpass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose. c) Base metal shall be preheated, notwithstanding provisions of IS:9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress. TABLE – 1 MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING <table> <tr> <th>Thickness of thicker part at point of Welding</th><th>Welding using Low hydrogen electrodes or Submerged arc welding</th></tr> <tr> <td>Upto and including 20mm</td><td>None</td></tr> <tr> <td>Over 20mm and upto and including 40mm</td><td>20 °C</td></tr> <tr> <td>Over 40mm and upto and including 63mm</td><td>66 °C</td></tr> <tr> <td>Over 63mm</td><td>110 °C</td></tr> </table> c) Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending upto a distance of four times the thickness of the plate on either side of the welding joint is obtained. d) Thermo-chalk, thermo-couple or other approved methods, shall be used for measuring the plate temperature. e) All butt welds with plates thicker than 50mm and all site butts weld of main framing beam shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done upto 600 deg.C and rate of application shall be 200 deg.C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5cm. thickness. For maintaining slow and uniform cooling, asbestos pads shall be used	Thickness of thicker part at point of Welding	Welding using Low hydrogen electrodes or Submerged arc welding	Upto and including 20mm	None	Over 20mm and upto and including 40mm	20 °C	Over 40mm and upto and including 63mm	66 °C	Over 63mm	110 °C
Thickness of thicker part at point of Welding	Welding using Low hydrogen electrodes or Submerged arc welding										
Upto and including 20mm	None										
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Over 63mm	110 °C										
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	for covering the heated areas. Sequence of Welding a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom. b) Each case shall be carefully studied before finally following a particular sequence of welding. c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together. d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process. e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed. f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted. g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies. h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks. i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement. j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation. k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the design drawings. l) Intermittent welds shall be permitted only when shown in the design drawings. m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.		
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	Testing of Welders All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX/AWS D1.1. All the necessary arrangements required for the testing of welders are to be provided by the Bidder. Inspection of Welds a) Visual Inspection 100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the welds run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, stages on the surface and visible cracks. Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag, etc., If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken. b) Production Test Plate Test plates shall be incorporated on either side of at least one main butt welds of each flange plate and web plate of every main frame columns and crane girder. The weld shall be continuous over the test plate. The test plate extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Engineer or his authorised representative. Should any of these tests fail, further radiographic examination of the welds shall be done. These tests for test plates and radiographic examination are additional to those contemplated under inspection and testing. c) Non-destructive and special testing Radiographic / ultrasonic or other non-destructive examination shall be carried out. All tests of welds shall be carried out by the Bidder at his own cost. The cordoning of radiation zone, while Radiography testing is going on, shall be done. In case of failure of any of the tests, re-testing of the joints shall also be carried out after rectification is done. d) Rectification of defective welding work Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc., are noticed by visual inspection/other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes.		
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	Inspection and Testing a) Fillet Welds i) All fillet welds shall be checked for size and visual defects. ii) Macroetch examination on production test coupons for main fillet weld with minimum one joint per built up beam, column and crane girder, etc. iii) 25% weld length of tension members of crane girder shall be subjected to dye-penetration test. iv) On all other welds, dye-penetration test on 5% of weld length with minimum 300mm at each location shall be carried out. b) Butt Welds i) 100% visual examination. ii) Dye penetration test on all butt welds after back gouging shall be carried out. iii) Mechanical testing of production test coupons - minimum one joint/built up beam, column and crane girder. The engineer may reduce the frequency of the test, after getting consistently satisfactory results of initial 10 tests. iv) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder and bunker supporting girders. All other butt welds shall be subjected to radiography test on 10% of weld length of each welder. c) Dimensional Tolerance and Acceptance Criteria of Welds i) Every first and further every 10th set of identical structure shall be checked for control assembly at shop before erection. ii) All structures, components/members shall be checked for dimensional tolerance during fabrication and erection as per IS:7215 and IS:12843 respectively. iii) Dry film thickness after painting shall be checked by using elchometer. iv) Acceptance criteria of NDTs on welds shall be as per AWS D-1.1 (Dynamically loaded structures - Tension welds). Correction of Defective Welds Correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed magnetic particles inspection or any other equally positive means shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed. Erection of Structures All erection work shall be done with the help of cranes, use of derrick is not envisaged.			
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	Erection Marks a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon. d) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site. Erection Scheme a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc., Bidder shall take up the erection work only after he has obtained the approval of the erection scheme from the Engineer. b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc. c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.			
8.07.00	Steel Helical Springs And Viscous Dampers			
8.07.01	General Requirement This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers. The Steel helical springs and viscous dampers supplied should be of proven make.			
8.07.02	Codes and Standards Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below: DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses. DIN : 2089 Helical compression springs out of round wire and rod : calculation & design. DIN : 2096 Helical compression springs out of round wire and rod; quality			
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8.07.03	requirements for hot formed compression springs. VDI : 2056 Criteria for assessing mechanical vibrations of machine. VDI : 2060 Criteria for assessing the state of balance of rotating rigid bodies. Design & Supply of Material i) Supply Steel helical springs and viscous dampers and associated auxiliaries shall consist of: (a) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc. (b) Frames for pre-stressing of spring elements. (c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided. (d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers. ii) Design The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units. The Steel helical springs and viscous dampers shall be designed for a minimum operating life of 30 years.		
8.07.04	Manufacturing & Testing Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include (a) Manufacturing schedule and quality check exercised during manufacturing. (b) Detail of test to be carried out at the manufacturing shop with their schedule. (c) Special requirements, if any, regarding concreting of top deck. (d) Complete step-by-step procedure covering the installation and commissioning of the spring system.		
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	(e)Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers. (f)A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers. (g)Checklist for equipment required at each stage of erection. (h)Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply. (i)Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers. (j)Any other details which may be necessary to facilitate design and construction of the foundations / structures.			
8.07.05	The Springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedure shall be finalised on the basis of the above codes and the quality plans be drawn accordingly.			
8.07.06	Transportation Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.			
8.07.07	Erection and Commissioning Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor. The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".			
8.07.07	Supervision The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.			
8.07.08	Realignment of Spring System If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.			
8.07.10	Acceptance Criteria Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed:			
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	General workmanship is being good as recommended by the manufacturer and approved by the Engineer. Tolerances are within the specified limit. Material test certificate (MTC) is in compliance with the applicable codes / standards. Bought out material is from the approved manufacturer / vendor. Bought out material is matching with the approved sample.		
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9.00.00	Architectural Concepts and Design			
9.01.00	For Architectural Concepts and Design refer to 5.00.01 in this specification.			
9.02.00	General Architectural Specifications			
9.02.01	General a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing ht to be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanised as per IS : 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level. In Service Building, Administrative Building, Plant Auditorium and Canteen Building RCC stairs and passages/ corridors hand railing with posts shall be made of stainless steel and be 1200mm high. For Atrium areas, same shall be provided with 10mm thick laminated Glass infill panels. For RCC stairs, passages & Atriums in buildings, around all floor openings at operating floors, 1000 mm /1200mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided. The spacing of vertical posts shall be 1500mm. Two number of horizontal rails shall be provided including the top member. Toe guard and kick plate shall be provided above the floor level. b) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise. For Administration Building& Service Building, stairs width shall be minimum 1500 mm, with Riser 150mm and Tread 300 mm. c) All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb at the edge of the floor along the metal cladding. 1000 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view. d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels. e) RCC staircase shall be provided for main entrance of Turbine building; control tower area and all other RCC construction buildings. f) Parapet, Chajjas 450mm over window and 600mm door heads, 900mm over rolling shutters, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3. g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In			
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9.03.00 9.03.01 9.03.02	detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed. h) Ramps & Lifts for physically challenged persons shall be provided for barrier free access to the buildings. Water Supply and Sanitation Two numbers of roof water tanks (one for storing service water and another for potable water) of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc. Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required. Sand Cast Iron pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level. All Buildings shall be designed with Toilets as per NBC norms. Minimum one number main toilet block for Gents & ladies separately, with required facilities shall be provided on each floor of Service building Administration building and Canteen building. Toilets for physically handicapped shall be provided as mentioned. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed. Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (fancy type). For GRIHA rated Buildings all fittings shall conform to GRIHA requirements, for water efficiency. a) One number wall mounted coloured (excluding premium colours) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556 b) One number white glazed vitreous China Orissa pan (580 x 440 mm) and flushing valve system, toilet paper holder as per IS:2256 c) One number colour (excluding premium colours) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 18mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However for Pump Houses the same shall be provided without photo voltaic control system for water control. d) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS:2556. e) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser		
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	f) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements g) In addition to the facilities stipulated elsewhere Bathroom with rotating type chromium plated shower including all fitting and fixtures shall also be provided in toilet at ground and operating floor of main plant: h) Janitor Space & space for drinking water cooler. i) Electric operated hand dryer with photo voltaic control. j) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number HDPE loft type / over head water storage tank, as per IS : 12701 and of 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, GI concealed water supply pipe of minimum 12 mm dia of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise) k) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556 (Part-5). l) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage.			
9.04.00	Flooring Floor finishes of approved shade and colour (non - premium colours), over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.			
9.04.01	The nominal total thickness of floor finish shall be 50 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade. Stone chips shall be 12.5 mm down well graded(& proper filling shall be done with brick bats/cinders). Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.			
9.04.02	Sunken slabs shall be made water tight by suitable water proofing treatment.			
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9.04.03	Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)			
9.04.04	Heavy duty cement concrete tiles 300 mm x 300 mm shall be in using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS:1443.			
9.04.05	Heavy duty (grade-5) dust pressed ceramic tiles (300mmx300mm shall be as per IS 15622. Designer ceramic wall tiles of size 300 mm x 200 mm / (300x600mm).			
9.04.06	20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar, pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar up to a depth of 20 mm and bituminastic end sealing.			
9.04.07	Mirror polished/ Matt finish (80:20) Vitrified ceramic tiles (min 9.5mm thk) with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile. Sizes of the tiles shall be as under: a) 600 mm x 600 mm b) 800mm x 800mm			
9.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.			
9.04.09	PVC flooring, wherever used, shall be minimum 2 mm thick (virgin) as per IS: 3462. The laying of flooring shall be as per IS: 5318.			
9.04.10	Epoxy Flooring Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer. It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.			
9.04.11	Wherever required, carpet flooring shall be provided over cement concrete floor as in conference room of main control room complex. The carpet shall be of tile/roll form, machine/hand made tupled un-cut loop pile and lay with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.			
9.04.12	Mirror polished (6 layers of polish) Granite stone (slab) - 18 mm Thk (minimum) / Flame finish (making top surface rough by burning / shot blasting) granite stone (slab) - 18 mm Thk (minimum) shall be provided.			
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9.04.13	Mirror polished Marble stone (slab) - (Rajnagar) Plain white -18 mm thick shall be provided in main stairs & 18mm thick kota stone shall be provided in the fire escape stairs.				
9.04.14	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.				
9.04.15	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto 2200 mm height from finished floor level. Skirting and Dado shall match with the floor finish.				
9.04.16	Wherever required, removable metallic false flooring system shall be provided. Nominal height of the false flooring shall be 600 mm. The same shall comprise of special grade steel panels (of size 600x600mm). without any dimensional tolerance 1.2mm thick die cast to shape having 1mm thick top MS sheet spot welded together to form a composite steel panel, sitting on aluminum diecasted heads & mounted on steel pedestals of 25mm dia rod of adjustable height and supporting 1.2mm thick channel frame work at-top and 2mm thick 150x150mm base plate. The top finish shall be 2mm thick antistatic PVC sheet or High pressures laminate. Cavity area below the false flooring shall be made dust proof by using Polyurethane paint.				
9.04.17	Interlocking concrete blocks shall be of various sizes and thickness having M 35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.				
9.04.18	Matt finish (with grooves) Porselin tiles (for guiding band/s for visually impaired persons) shall be with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile. 24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern. Laminated wooden flooring shall be provided in VIP area, conference rooms & auditoriums.				
9.04.19	Paving a) Ground floor of all buildings shall be provided with normal duty paving with 50mm thick metallic hardener floor finish. For details of normal duty paving refer to description elsewhere in this specification. b) PCC paving of nominal mix 1:2:4 (1 part cement: 2 parts sand: 4 parts aggregate), 100 mm thick laid over 75 mm thick bed of dry brick aggregate shall be provided for following areas: i) 750 mm wide plinth protection around all buildings other than those covered under paved area. ii) 2.0 m wide pathway all along pipe/ cable corridor and all around each cooling tower. 2.0 mm wide ways inter connecting all cooling towers with each other.				
9.05.00	Acid/ Alkali Resistant Lining				
9.05.01	The material shall conform to the following: i) Bitumen primer shall conform to IS: 158.				
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	ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412. iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively. iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.			
9.05.02	Requirements for acid/ alkali resistant flooring and lining for different areas shall be as given Table-A enclosed at the end of this specification. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.			
9.06.00	Roof			
9.06.01	Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile having minimum base metal thickness of 0.8mm of galvanised (with minimum rate of galvanisation of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.			
9.06.02	Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM - C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade conforming to IS: 13801 shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.			
9.06.03	For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.			
9.06.04	For Building where metal cladding is envisaged medium class galvanised mild steel pipes conforming to IS: 1239/IS:3589 with welded joints shall be provided to drain off rain water from the roof. For rest of the buildings cast-iron pipes with lead caulked joints conforming to IS:1230 shall be used. These shall be suitably concealed with masonry work, cement			
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	concrete / or sheeting work to match with the exterior finish. The number and size of down comers shall be governed by IS:1742 and IS:2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures. Gratings shall be of stainless steel.			
9.06.05	Roof of the buildings that shall conform to minimum 4 star GRIHA Rating shall have over deck insulation with minimum 75 mm thick Extruded Polyurethane foam with minimum density 18 kg/Cu.m. above water proofing with mortar and Joints sealed with adhesive tape over roof and above it White glazed tile chips shall be provided for roofing over under bed of cement mortar/concrete including all workmanship, topping spreading white cement slurry at an average rate of 2.5 kg/sq m(unless noted otherwise)jointing and joint filling with white cement slurry (unless noted otherwise) ,laying to plumb and water level in desired pattern ,casting in panels .			
9.06.06	Roof Water Proofing Roof water proofing treatment shall be as follows: a) For roofs having structural slope: Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also. b) For roofs having no structural slope: Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also			
9.06.07	Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.			
9.06.08	RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.			
9.06.09	Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.			
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9.06.10	Pathways for handling of materials and movement of personnels shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm .			
9.07.00	Walls			
9.07.01	All walls shall be non-load bearing infill panel walls.			
9.07.02	For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever metal cladding is specified.			
9.07.03	All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).			
9.07.04	For Administration building, Service Building, Auditorium Building and Canteen Building Autoclaved Aerated Concrete blocks shall be used. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm. thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part-III) .The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (100 mm /125 mm thk.) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry , joint reinforcement etc. in the AAC masonry work strictly be carried out as per instructions laid down in .I.S 6041 – 1985, I.S -1905.			
9.07.05	For control room , control equipment room and ESP building wall shall be of factory made composite modular light weight aerated concrete panels,(minimum 4 hours of fire rating) consisting of 2 fiber reinforced cement sheets (minimum 4 mm thick) on either side of light weight concrete core, having minimum compressive strength of 35 Kg / Cm2 and the density in the range of 700-900 Kg. / cu.m. of the thickness and fire rating as specified below, to provide external wall and internal partition at all levels, capable of sustaining wind pressure of 4.50 M height (H) within limiting deflection of span/250, fixed in position in tongue and groove jointing system by screwing the panels to top and bottom U channels, (channels minimum 1.25 mm thick and galvanised to grade 180 (minimum) as per IS : 277), fixing U profiled top and bottom channels to concrete / primary steel members which are placed at the maximum vertical spacing of 4.5m with the help of galvanised steel expansion fasteners, filling the joints from both faces with silicon acrylic paste and making the same water tight by covering with fibre glass tape (minimum 50 mm wide and minimum 0.5 mm thick) or by any other suitable material, so as to ensure that the entire construction done with the light weight aerated concrete panels are weather proof and panel surfaces are flush for painting, creating opening for doors / windows /ventilators / ducts / pipes/fans/AC etc. and finishing the opening face with the same U profiled galvanized steel channel which is used at the top and bottom.			
9.07.06	For Main plant building, Control tower and other buildings, the type, thickness and initial height of external cladding facing the transformer yard shall be according to the requirements. External face of Toilets, Air-conditioned and pressurised areas shall be provided with masonry wall as per functional / aesthetic requirements. (Inside the metal cladding wherever provided).			
9.07.07	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS:702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.			
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9.08.00	Colour coated and other sheeting work			
	Permanently colour coated sheet of approved shade and colour using galvanised mild steel sheet of minimum 0.6mm BMT(bare metal thickness i.e. metal thickness excluding thickness for coating and galvanizing) galvanised to grade 275 as per IS 277, of minimum yield strength of grade SS255 as per ASTM A653M / grade G250 as per AS 1397, coated with zinc of class designation Z275 or high tensile steel of minimum 0.5mm BMT(bare metal thickness i.e. metal thickness excluding thickness for zinc aluminium coating and colour coating) of grade SS340-Class 4 as per ASTM A792M / grade G350 as per AS 1397, coated with aluminium zinc alloy of class designation AZ150.			
	For profiled colour coated metal deck sheet, minimum 0.8 mm BMT (bare metal thickness i.e. metal thickness excluding thickness for coating and galvanizing) of grade SS255 as per ASTM A653M / grade G250 as per AS 1397, coated with zinc of class designation Z275, troughed profile having nominal trough depth 44 mm and pitching of 130 mm shall be used. However alternative profile meeting the strength, defection and other functional requirements such as sections modulus and moment of inertia shall be provided. To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purling / runner spacing.			
	Steel shall be colour coated with total coating thickness of 35 microns (nominal) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Polyester paint, of minimum 20 microns (nominal) dry film thickness (DFT) on external face on 5 microns (nominal) primer coat and 5 microns (nominal) SMP or super polyester paint over 5 microns (nominal) primer coat on internal face. SMP and Super polyester paint systems shall be of industrial finish of product type 3 of AS2728. Coated surface shall be provided with a protected guard film (polyethylene) of about 40 microns to avoid any damage to the coating during handling.			
	No negative tolerance shall be allowed in bare metal thickness.			
	For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. The nominal depth of trough shall be 30 mm.			
	Sheet shall be of approved profile, sectional properties, colour and shade.			
	For profiled metal decking sheets (to be used for RCC floor slab) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sqm for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS:801 for satisfying the deflection and strength requirements.			
	For metal deck sheets used for RCC roofing and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS:801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.			
	The maximum spacing of the fasteners shall preferably be 390 mm c/c along the length of purlins/runners. However exact spacing shall be as per the design done by the bidder for the			
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	fasteners considering the wind load, self load and other associated loads. Minimum diameter of the fastener shall be 5.5 mm and atleast 3 nos. of fasteners shall be used per sheet. Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 275 as per IS : 277 Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer. For insulation of cladding and other areas, mineral wool conforming to IS : 8183 shall be used. The density shall be 32 or 48 kg. /Cu.M. for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm. The polycarbonate sheet to be used for cladding and glazing purpose in conveyor galleries shall have toughed profile to match with the metal cladding profile. Minimum 2.0mm thick fire retardant and UV resistant polycarbonate clean sheet of GE plastic or equivalent approved make shall be used. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS : 14434 to be referred for other details. Polycarbonate sheet minimum 2mm thick fire retardant impact resistant and ultraviolet resistant sheet shall be provided (as glazing) in transfer houses, pump houses, etc. All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealnts with appropriate material and coating specification as mentioned above for the outer face of the sandwiched metal cladding. Overlap shall be min. 100 mm or as specified by manufacturer. For buildings where insulated sandwiched double metal sheets shall be used for Roof. The sandwich sheet combination shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated for covering of exposed metal/ concrete / brick surfaces with 50mm thick insulation sandwiched between the two sheets, each sheet shall be of steel with zinc coated to class 275 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.6mm of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 or of steel with aluminium-zinc alloy coated to class AZ150 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.5mm of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 or of steel with aluminium-zinc alloy coated to class AZ150 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.4mm of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 or alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS:737 and IS:1254, steel / aluminium both colour coated with total coating thickness of 35 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of 20 microns (nominal) SMP or polyester paint on one side (exposed face), over 5 micron (nominal) primer coat and 5 micron (nominal) SMP or Polyester paint over 5 micron (nominal) primer coat on other side (SMP and Super Polyester paint shall conform to product type 4 of AS/NZS 2728), troughed sheet shall be of approved profile, sectional properties, (suitable for the specified loading / deflection and purlins / runner spacing), colour and shade, at all levels, including all labour, materials, equipment, handling, transportation, special coated fastener conforming to corrosion resistant Class 3 of AS3566 and tested for 1000 hours salt spray		
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	test, fixing insulated sandwiched metal sheeting assembly with the structural members below for supporting the sheeting system, scaffolding, equipment, end and side laps, cutting of openings, preparation of working drawings, testing, etc., all complete, as per specifications			
9.09.00	Plastering			
9.09.01	Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.			
9.09.02	Plaster of paris (Gypsum Anhydrous) conforming to IS:2547 shall be used for plaster of paris punning over cement plastered surfaces. The finish surface shall be smooth and shall be of 2 mm nominal thickness.			
9.09.03	All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.			
9.09.04	All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.			
9.09.05	Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.			
9.09.06	All plastering work shall conform to IS:1661.			
9.10.00	Painting & Aluminium Composite Panel Cladding			
9.10.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.			
9.10.02	All paints shall be of approved make including chemical resistant paint.			
9.10.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer.			
9.10.04	Solvent based (100% pure acrylic co-polymer resin based) paint shall not contain any water sensitive ingredients. Paint shall be applied in two or more coats as required on an under coat of suitable primer or one coat of cement paint on the new plastered surfaces inclusive of required tools, material and other painting accessories etc. The paint is to be applied as per the specifications, instructions and satisfaction of Engineer-in-charge.			
9.10.05	Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 18 mm thk / polished Sadarhally grey granite slab 18 mm thk). The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.			
9.10.06	Acrylic emulsion paint shall be as per IS:15489. Acrylic distemper shall be as per IS:428. Cement paint shall conform to IS:5410, white wash/colour wash shall conform to IS:627.			
9.10.07	Fire resistant transparent paint as per IS:162 shall be provided on all wood work over French polish or flat oil paint. French polish shall conform to IS:348. Flat oil paint shall conform to IS:137.			
9.10.08	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.			
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9.10.09	For painting on concrete, masonry and plastered surface IS:2395 shall be followed. For painting on wood work IS:2338 shall be followed.			
9.10.10	For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.			
9.10.11	Bitumen primer used in acid/alkali resistant treatment shall conform to IS:158.			
9.10.12	All internal paints shall be of low VOC content conforming to GRIHA rating for reduction of VOC content.			
9.10.13	Resin bonded granular textured finish, for external applications shall consist of crushed stone / quartz chips of 2.5 mm size and of approved colour/ shade and bonded with synthetic resins, Adhesives and additives, all together in a single pack mix. For internal finish 1.2mm of approved, colour & shade (pigmented granular or flake finish) The final finish shall have UV-Resistant, fungus/bacterial resistant properties. Grooves shall be provided as per drawing and the same shall be filled with polysulphide sealant of matching colour/shade.			
9.10.14	Aluminium Composite Panel Aluminum Composite Panels for external wall cladding at all heights and elevation shall be fixed on to the supporting steel members, masonry wall, fastening material and hardware complete with all labour, material, equipment, handling, transportation, workmanship, preparation of working drawings, staging, scaffolding, etc., all complete. The aluminum composite panel should consist of 3mm thick thermoplastic core of anti oxidant LDPE sandwiched between 2 skins of 0.5mm thick aluminum alloy sheet making a total panel thickness of 4mm. The surface shall be finished with PVDF based coating of minimum 30 micron on the topsides and services coating on the reverse side shall be with polymer paint. Coating shall conform to ECCA or AAMA.the surface shall be protected with self adhesive peel of masking foil. The system shall be designed to withstand a wind pressure of 200kg/Sqm and shall be fixed to he Masonry/RC walls with necessary clamps, brackets and anchor fasteners. All clamps and brackets shall be Hot dip galvanized minimum 80 microns thick and shall conform to IS: 4759-1996. The extruded aluminum section shall be anodized in approved colour with a anodic coating of minimum 20 microns. Extruded section shall be 6063 T5 or T6 alloy conforming to ASTM B221. Any other festering straps, nuts, bolts, rivets, washers, etc. shall be in stainless steel SS304 grade. EPDM gaskets, open cell polyethylene backer rods, weather sealant etc. shall be provided as per requirement. Aluminium Composite Panel for internal encasement shall be with II B fire rated LDPE core mixed with mineral fibre.			
9.10.15	Solvent Based Exterior Paint The paint should be applied in minimum three coats as required on an undercoat of suitable primer or one coat of cement paint on new cement plastered surfaces inclusive of required tools, materials, scaffolding and other painting accessories etc. The paint shall be applied as per manufacturer's specifications and instructions and to the entire satisfaction of engineer-in-charge. The paint shall be solvent based (resin based). The coating shall be resistant to alkali, acids, & mould growth. The paint shall not contain any water sensitive ingredients. it shall have excellent water resistance property. All loose & flaking materials shall removed. All cracks and structural defects shall be made good. All surfaces must be dry and free from mould, algae & grease. If there is evidence of organic growth, vigorous cleaning shall be			
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	done either manually or mechanically which is essential. the surface shall be sterilized with bleaching powder solution and rinsed with water after twenty four hours. 9.11.00 Doors & Windows 9.11.01 Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of all buildings (unless otherwise mentioned) shall have, electro colour dyed (anodised with 15 micron coating thickness) aluminium framework with glazing. All doors of toilet areas shall be of steel framed solid core flush shutter. For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided. 9.11.02 Main entrance of the common control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing. Doors shall be of double action floor springs mounted. 9.11.03 For common control building, double glazed wall panels with 24mm thick hermetically sealed toughened , fire resistant glass with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of common control room and control equipment room(s) to have a clear view. One glass, on external side of control room shall be tinted one. Internal partition in control room shall be with 10mm thick toughened fire resistant Glass. 9.11.04 Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary. 9.11.05 - The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS:4351. - All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc. 9.11.06 Steel windows and ventilators shall be as per IS:1361 and IS:1038. 9.11.07 Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used. 9.11.08 All windows and ventilators on ground floor of all buildings shall be provided with suitable Aluminium grill. 9.11.09 Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall generally be as per IS:3614 Part-II. Fire rating of the doors shall be of minimum 2 hours. These doors shall be double cover plated type with mineral wool/wood insulation. 9.11.10 Hollow extruded section of minimum 2 mm wall thickness as per IS:1285 shall be used for all aluminium doors, windows and ventilators.		
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9.11.11	Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.			
9.11.12	Electrically operated, self operable/closing, aluminium framed with tinted glass . sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building.			
9.12.00	Glazing			
9.12.01	All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, plain or tinted for preventing solar radiations, unless otherwise specified.			
9.12.02	All inaccessible (where regular maintenance is not feasible) ventilators and windows of all buildings shall be provided with 6mm thick clear toughened glass. 2 mm thick polycarbonate sheet with profile matching with metal sheeting shall be provided in TPs, conveyor galleries and Mill Bunker Building. The Polycarbonate sheets shall be fire and u/v resistant, and suitable for continuous use up to a temperature of 100 ⁰ C. Suitable aluminium beading shall be used. The open ends of the sheet shall be sealed as per manufacturer's recommendations.			
9.12.03	The sky light/ dome / north light shall have minimum 10mm thick Multiwall Polycarbonate sheet fixed with anodised aluminium frame of approved colour & the same shall be made leak proof.			
9.12.04	All windows and ventilators located in fire prone areas shall be provided with minimum 6 mm thick toughened glass conforming to IS:5437.			
9.12.05	For single glazed aluminium partitions and doors, 8mm or 10 mm thick clear toughened glass shall be used.			
9.12.06	Ground glass of minimum 4 mm thickness shall be used for all windows/ventilators in toilets.			
9.12.07	All glazing work shall conform to IS:1083 and IS:3548.			
9.12.08	For main plant glazings, 6mm thk clear reflective toughened glass shall be provided. The glass to be used should be from the manufacturers of glass like Saint Gobain (India) or Asahi (India) or equivalent. The glass should be free from distortion and thermal stress.			
9.12.09	For glazings of Air Conditioned Buildings Composite double glazing shall be 24mm thick consisting of 6mm thick clear float glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminium with outer edge sealed with silicon sealant. Outer glass of 6mm thickness shall have following technical characteristics: Solar factor 25% or less, U-value less than 2.268 W/ SQMK,VLT min 30%: The glass to be used should be from the manufacturers of glass like Glavebel (Belgium), Saint Gobain (France) or Fort (USA) Or equivalent. The glass should be free from distortion and thermal stress. For CER & Control room, 24 mm thick hermitically sealed double glazing with toughened, fire resistant plane glass & tinted glass shall be provided. For glazing in non A/C areas of A/C Building single 6mm thick reflective glass shall be provided.			
9.12.10	Glass block masonry work with glass blocks of size 190 x 190 x 90 (min), jointed with suitable adhesive complete as per the best construction practices.			
9.12.11	For internal glazed partition, 8mm thick & 10mm thick clear toughened glass shall be provided.			
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9.13.00	False ceiling			
9.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum 0.8 mm thick and galvanised as per IS : 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS : 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome)			
9.13.02	False ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanised light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600. as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete.			
9.13.03	False ceiling of 12 mm thk calcium silicate board of 'HILUX' or equivalent with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).			
9.13.04	Aluminium false ceiling shall be in 600 mm x 600 mm tile of 0.6 mm thk. alluminum with perforation patterns in combination with built in nonwoven tissue, for providing good acoustic properties and installed with T-Grid (of profile 24 mm) in same or contrasting colours or with 6 mm recess joints. The whole system shall be level adjusting arrangement and shall be suspended as per manufacturer guidelines of Luxalon, Armstrong or equivalent.			
9.13.05	Pre-Painted Coil coated Steel false ceiling system, at all level, for all kind of works, consisting of 0.5 mm thick galvanised as per IS : 277, along with galvanised supporting steel members exposed faces of galvanised member to be prepainted with regular modified polyester coating / super polyester coating minimum 20 DFT, to form panels of specified size for tile type panels and roll formed stove enamelled 0.6 mm thick steel carrier, for fixing of lineal type panels by clip on arrangement, suspended from RCC slab / structural steel or catwalk way steel channel grid above with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm leg width along the perimeter of ceiling, including all labour, material, supporting grid system (members minimum 0.8 mm thick and galvanised as per IS : 277) anchor fasteners for making suspension arrangement from RCC, providing openings for AC ducts, return air grills, insulation light fixtures, etc., all complete.			
9.13.06	Tile type steel false ceiling system in square pattern panels of 600 mm x 600 mm size along with galvanised light gauge rolled form. supporting system in double web 'T' construction with pre-painted steel, with Tee support.			
9.13.07	Lineal pattern (closed type) of 100 mm nominal width, with carrier support. Metal ceiling as above in lineal/tile shape in stainless steel, bright finish instead of pre-painted coil coated finish.			
9.13.08	Mineral wool insulation shall be laid on top of false ceiling panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.			
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9.13.09	Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.			
9.12.10	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thk. mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.			
9.13.11	Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.			
9.14.00	Interior Design A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the mutlidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance. The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification. a) Layout, keeping in view the man-machine interface and suitable ergonomic practices. b) Integration of civil engineering with architecture and interior design. c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture. d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc. e) Microprocessors based control system to control the functional requirements. The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.			
9.15.00	Finishing Schedule Interior and Exterior Finishes shall be as given in Tables-B & C respectively attached at the end of these specification.			
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TABLE -B						
INTERIOR FINISHING SCHEDULE						
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING		
	i) General circulation and movement areas	18mm thk. Polished granite stone / marble stone/ Vitrified Ceramic tiles.		Acrylic distemper (except metal deck area).		
	j) Switchgear room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper		
	k) MCC Room	- do -	- do -	- do -		
	l) Control room area including control room, computer room,	Vitrified ceramic tiles	Partition in glass with anodized Aluminium frame& Aluminium composite panel cladding for columns	Mineral fibre board false ceiling / Aluminium false ceiling		
	m) control equipment room,	Vitrified ceramic tiles	vitrified ceramic tiles for wall cladding& Aluminium composite panel cladding for columns	Metal panel false ceiling in approved pattern.		
	n) Conference room, senior executive room.	Laminated wooden flooring	Glazed partition with anodized Aluminium frame/ Acrylic emulsion paint.	Mineral fiber board false ceiling.		
	o) Record room	Heavy duty dust pressed ceramic tiles	Acrylic distemper.	- do -		
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CLAUSE NO.		TECHNICAL REQUIREMENTS				NTPC	
TABLE -B							
INTERIOR FINISHING SCHEDULE							
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING			
	p) Locker room	Heavy duty dust pressed Ceramic Tiles	Acrylic distemper.	Acrylic distemper			
	q) Toilet area	Heavy Duty Dust pressed ceramic tiles and 18mm thick. Polished granite in one piece for wash basin platform.	Designer ceramic wall tiles upto 2.1m ht. and Acrylic distemper for balance height.	Acrylic distemper / Calcium Silicate false ceiling.			
	r) Office Room, Staff Room/Library	Vitrified ceramic tiles.	Acrylic emulsion paint.	Mineral fiber board false ceiling..			
	s) Laboratory area	Heavy duty dust pressed ceramic tiles.	Designer ceramic wall tiles up to 1.2m ht.& rest Acrylic distemper/chemical resistant paint.	Gypsum board false ceiling as/profile or chemical resistant paint.			
	t) RCC Stair case	18mm thick Marble stone	Vitrified Ceramic Tiles upto 1.2m. ht. & Resin bonded granular texture finish for balance height.	Acrylic Distemper			
	u)Lift areas.	18mm thick polished marble stone/ granite stone as/ pattern.	Acrylic emulsion paint or 18mm thick polished marble/ granite cladding.	Metal panel false ceiling			
	v)Passages and general circulation areas.	18mm thick polished Marble Stone/ granite stone.	Acrylic Distemper / acrylic emulsion paint.	- do- & Acrylic emulsion paint.			
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CLAUSE NO.		TECHNICAL REQUIREMENTS					
TABLE -B							
INTERIOR FINISHING SCHEDULE							
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING			
	w) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint.			
	x)Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based) 150 micron over primer.	As above except oil canal Oil resistant Paint	As above except oil canal.			
	y) Pathways including roof area.	22mm thick concrete chequered tiles.	-	-			
2.	Service Building/Auditorium Building	Admin					
	a) Entrance Lobbies and Lift areas/Foyer/Exhibition space/Canteen.	18mm thick polished marble stone/ granite as/ pattern.	Textured paint/ acrylic emulsion paint or 18mm thick polished marble/ granite cladding.	Gypsum Board False Ceiling as/profile/ Aluminum tile false ceiling.			
	b) Conference room, senior executive room.	Laminated wooden flooring	Glazed partition with Aluminium frame/ Acrylic emulsion paint.	Mineral fiber board false ceiling.			
	c) Office Room, Staff Room/Library.	Vitrified ceramic tiles.	Acrylic emulsion paint.	Gypsum Board False Ceiling as/profile or Metal Panel False ceiling in approved pattern.			
	d) Passage	Vitrified ceramic tiles.	Textured paint/ acrylic emulsion paint.	Metal Panel False ceiling/ Mineral fiber board false ceiling.			
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CLAUSE NO.		TECHNICAL REQUIREMENTS					
TABLE -B							
INTERIOR FINISHING SCHEDULE							
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING			
	e) RCC Stair case	Marble stone / granite stone.	Marble stone/ granite stone up to 1.2m.ht. & Textured paint above.	Acrylic Distemper.			
	f) Toilet/ Pantry/ Kitchen	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform..	Designer ceramic wall tiles dado upto 2.1 m. height and Acrylic distemper for balance area height. .	Acrylic distemper / Calcium Silicate false ceiling.			
	g) AHU/ A.C. Plant room/MCC Room/Store	Cement concrete with Metallic hardener topping.	Acrylic distemper	Acrylic distemper			
	h) Covered parking area	Pavers interlocking cement concrete blocks.	External finish	Acrylic Distemper			
	i) Pathways including roof area.	22mm thick concrete chequered tiles.					
	j) Green Room	Vitrified ceramic tiles.	Acrylic emulsion paint .	Gypsum Board False Ceiling			
	k) Seating Area	Cement concrete with Metallic hardener topping covered with carpet tiles/ wooden flooring	Wall paneling.	Gypsum Board False Ceiling /Mineral fiber board false ceiling as per acoustic requirement.			
	l) Stage	Cement concrete with Wooden flooring	Wooden paneling per acoustic requirement.	-do-			
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CLAUSE NO.		TECHNICAL REQUIREMENTS				
TABLE -B						
INTERIOR FINISHING SCHEDULE						
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING		
	m) Projector room	Dust pressed ceramic tile	Acrylic distemper	Acrylic Distemper		
3	ESP control building/Air compressor house/ARCW. building					
	a) Operating/Maintenance areas	Cement concrete with Metallic hardener topping	Pre color coated metal panel cladding.	Acrylic distemper (except metal deck area)		
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Acrylic emulsion paint		
	c) Control Room	Vitrified ceramic tiles.	Vitrified tile cladding on walls up to false ceiling& column encased with ACP.	False ceiling in lineal Metal panel		
	d) MCC Room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)		
	e) RCC Stair case	Marble stone / granite stone.	Vitrified tile up to 1.2m.ht. & Acrylic Distemper	Acrylic Distemper		
	f) Battery Room	Acid, Alkali resistant tile	Acid, Alkali resistant tile	Acrylic Distemper		
	g) AHU/ AC Plant room/ Cable vault	Cement concrete with Metallic hardener topping	Acrylic Distemper	Acrylic Distemper		
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TABLE -B							
INTERIOR FINISHING SCHEDULE							
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING			
	h) Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper/ Calcium silicate false ceiling.			
4.	Canteen/ Gate Complex/Fire station/ Construction Office						
	a) Reception/Waiting	Marble stone / Granite stone	Textured paint/ acrylic emulsion paint	Acrylic Distemper			
	b) Office/Guard Room/Conference/Viewing Gallery/ Staff room	Vitrified ceramic tiles.	Acrylic distemper/ acrylic emulsion paint	Acrylic Distemper/Mineral fiber board false ceiling./ Aluminium False Ceiling			
	c) Detention Room/ Ammunition store	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic Distemper			
	d) Sitting and General Area	Granite stone/Vitrified ceramic tiles.	Designer ceramic wall tiles up to 1.2 m, and Textured Paint for balance height. Glass mosaic tiles for murals & Glass blocks for interior purpose.	Acrylic distemper/ Gypsum board false ceiling./ Aluminium False ceiling			
	e) Kitchen, Pantry and preparation area	Heavy duty dust pressed ceramic tiles and Granite stone for platform	Designer ceramic wall tiles dado upto 2.1 m. height and Acrylic distemper for balance area height. .	Acrylic distemper			
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TECHNICAL REQUIREMENTS		TABLE -B INTERIOR FINISHING SCHEDULE			
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING	
	f) Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles.	Acrylic distemper / Calcium Silicate false ceiling.	
	g) Fire Tender area	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.	
	h) Stores	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.	
5.	CHP Maintenance Building /O&m store/O&M workshop building Dozer shed.				
	a) Workshop/stores/dozer shed	Cement concrete with Metallic hardener topping.	Acrylic distemper/ color coated Metal panel cladding	Acrylic distemper (except metal deck area)	
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	Mineral fiber board false ceiling/ Acrylic distemper	
	c) Passages	Vitrified Ceramic Tiles	Acrylic distemper	Mineral fiber board false ceiling/ Acrylic distemper	
	d) RCC Stair case	18mm thick polished Marble stone / granite stone.	Vitrified Ceramic Tiles 1.2m.ht. & Distemper above.	Acrylic Distemper	
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CLAUSE NO.		TECHNICAL REQUIREMENTS					
TABLE -B							
INTERIOR FINISHING SCHEDULE							
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING			
	e) Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles dado upto 2.1 m. height and Acrylic distemper for balance area height. .	Acrylic distemper			
6.	Mill& Bunker building/Track Hooper/T.P./Conveyer's gallery/Crusher						
	a) Mill& Bunker area/Track Hooper area/ T.P. area/Conveyer's gallery area/Crusher area	Cement concrete with Metalic hardener topping	Acrylic distemper on masonry walls/ color coated Metal panel cladding	color coated Metal panel cladding			
	a) Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper			
7.	Fire water pump house						
	a) Maintenance /Pump floor/PLC	Cement concrete with Metalic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)			
	b) Control room /PLC.	Epoxy flooring	Acrylic emulsion paint .	Mineral fiber board false ceiling.			
	c) Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper			
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INTERIOR FINISHING SCHEDULE					
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING	
8.	Fire water booster water pump house /Foam pump house.				
	a) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)	
	b) Control room /PLC.	Vitrified Ceramic Tiles	Acrylic emulsion paint .	Mineral fiber board false ceiling.	
	c) Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper	
9.	Ash slurry pump house/ Ash water pump house / Silo Area Utility Building / Ash Water recirculation Pump House/ Transport air compressor house/ HCSD pump house/ Ash Dyke Maintenance building.				
	a) Operating/Maintenance areas/ MCC room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)	
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Acrylic distemper.	
	c) Control room	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling.	
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TABLE -B					
INTERIOR FINISHING SCHEDULE					
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING	
	d) RCC Stair case	Marble stone / Granite stone.	Marble stone / Granite stone up to 1.2m.ht. & Acrylic emulsion paint	Acrylic Distemper.	
	e) Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper over plaster of Paris for balance height.	Acrylic distemper.	
10.	CWPH / DMPT buildings / & Other auxiliary building.				
	a) Workshop/ Operating/Maintenance areas/MCC areas	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)	
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Acrylic emulsion paint	
	c) Control room	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling/ Acrylic distemper	
	d) Acid/Alkali storage area/ CW treatment area/DM plant area/ Regeneration area/ Neutralization pit etc.	Acid, Alkali resistant tile as per requirement.	Acid/Alkali resistant tile as per requirement.	Acrylic Distemper	
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CLAUSE NO.		TECHNICAL REQUIREMENTS				
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INTERIOR FINISHING SCHEDULE						
S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING		
	e) RCC Stair case	Marble stone / granite stone.	Marble stone up to 1.2 m.ht. & Acrylic Distemper paint	Acrylic Distemper		
	f) Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles upto 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper		
Note : 1. All wall and roof areas above false ceiling shall be plastered and white washed. 2. The colour and pattern of finish shall be as per approved details. 3. All materials shall be of reputed and established brand approved by Engineer-in-charge. 4. Wherever alternative materials are specified, the final selection rests with Engineer-in-charge. 5. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities. 6. All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer. 7. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.						
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CLAUSE NO.			
TABLE –C			
EXTERIOR FINISHES SCHEDULE			
Sl.No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Main plant building & Fire walls in Transformer yard; Other Auxilliary building in steel framed structure.	Resin bonded granular texture finish of approved colour/colour combination over plastered surface on masonry/concrete. Approved colour/ colour combination of colour coated metal cladding	Solvent based (resin based) over plastered surface. Approved colour/ colour combination of colour coated metal cladding.
2.	Building with concrete frame work, etc.	solvent based resin based paint of approved colour/colour combination. For Service building/ Admin. Bldg. / canteen & Auditorium. Aluminium composite Panel Cladding in combination with Resin bonded Granular texture finish (50:50)	Solvent based (100% pure acrylic co-polymer resin based) over plastered surface.
3.	Steel Structure, trestles, etc.	High performance Paint of approved specification and shade.	
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	NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer. 2. All materials shall be of reputed and established brand approved by Engineer.	KHARGONE TPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION SUB-SECTION- CIVIL WORKS PAGE 214 OF 393

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10.00.00	MATERIAL SPECIFICATION			
10.01.00	Cement Fly ash based portland pozzolana cement conforming to IS:1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code. Ordinary Portland Cement (OPC) shall necessarily be used for the following structures. a) TG foundation top deck b) Spring supported decks of all machine foundations such as PA/FD/ID Fans and TDBFP/MDBFP c) RCC for Chimney shell. d) NDCT shell and racker columns of NDCT. The grade of cement shall be Grade 43 for OPC conforming to IS:8112. In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS:3812(Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement			
10.02.00	Aggregates a) Coarse aggregate Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383. b) Fine aggregate Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS : 383. For plaster, it shall conform to IS : 1542 and for masonry work to IS : 2116.			
10.03.00	Reinforcement Steel Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-500 and shall conform to IS:1786. However, minimum elongation shall be 14.5%. Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade-1 of IS:432 (Part-1) or grade A of IS:2062. Welded wire fabric shall conform to IS:1566.			
10.04.00	Structural Steel Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
10.04.01	Mild Steel a) Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall pass the impact test value at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2. b) Pipes shall conform to IS: 1161. c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240. d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.			
10.04.02	Medium and High Tensile Steel Rolled Sections and plates shall be of grade designation E350, Quality B0(killed), conforming to IS 2062. Plates beyond 20mm thickness and upto 40mm thickness shall be controlled rolling. Plates beyond 40mm thickness shall be normalizing rolling and shall also be ultrasonically tested as per ASTM –A578 level B.			
10.05.00	Bricks Bricks shall be table mounted/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 50kg/cm². Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS:13757 and IS:12894 respectively. Minimum fly ash content in fly ash based bricks shall be minimum 25%. Common burnt clay bricks shall conform to IS:1077.			
10.06.00	Foundation Bolts Material and details of foundation bolts shall conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS432 and/ or grade A of IS:2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 upto M36 diameter and IS 5624 for M42 to M150 diameter.			
10.07.00	Stainless steel The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.			
10.08.00	Water Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
10.08.00	time of concrete shall meet the requirements of IS:456.			
	All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.			
	Statutory Requirements			
	Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc. Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc. Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tariff Advisory Committee. Statutory clearances and norms of State Pollution Control Board shall be followed. Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.			
11.00.00	Inspection, Testing And Quality Control			
11.01.00	Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding), piling, sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.			
	The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.			
11.02.00	Workmanship and dimensional shall be checked as stipulated below.			
12.00.00	ANNEXURES			
	(a) List Of Codes And Standards All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as given in Annexure-a of this specification.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	Annexure-(a) <u>LIST OF CODES AND STANDARDS</u> Excavation and Filling - IS :2720 Methods of test for soils(relevant parts) - IS:4701 Code of practice for earth work on canals. - IS:9759 Guide lines for dewatering during construction. - IS:10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade. Properties, Storage and Handling of Common Building Materials - IS:269 33 grade for ordinary Portland cement. - IS:383 Coarse and fine aggregates from natural sources for concrete. - IS:432 Specification for mild steel and medium tensile steel bars and (Part 1&2) hard drawn steel wires for concrete reinforcement. - IS:455 Portland slag cement. - IS:702 Industrial bitumen. - IS:712 Specification for building limes. - IS:1077 Common burnt clay buidling bricks. - IS:1161 Steel tubes for structural purposes. - IS:1239 Mild steel tubes, tubulars and other wrought steel filting - MS tubes. - IS:1363 Hexagon head bolts, screws and nuts of productions (Part 1-3) grade - C. - IS:1364 Hexagon head bolts, screws and nuts of productions (Part 1-5) grade-A & B. - IS:1367 Technical supply condition for threaded fasteners. (Part 1-18) - IS:1489 Portland-pozzolana cement. (Part-I) Fly ash based - IS:1542 Sand for Plaster.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		एनडीपीसी NTPC	
	IS:1566	Hard drawn steel wire fabric for concrete reinforcement.		
	IS:1786	High strength deformed steel bars & wires for concrete reinforcement.		
	IS:2062	Hot Rolled Low, Medium and High Tensile Structural Steel		
	IS:2116	Sand for masonry mortars.		
	IS : 2185 (Part 1)	Hollow & solid concrete blocks.		
	(Part 2)	Hollow & solid light weight concrete blocks.		
	IS:2386 (Part I-VIII)	Testing of aggregates for concrete.		
	IS:3812	Specification for fly ash for use as pozzolona and admixture.		
	IS:4082	Recommendation on stacking and storage of construction materiel and components at site		
	IS:8112	43 grade ordinary portland cement.		
	IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).		
	IS:12269	53 grade ordinary portland cement.		
	IS:12894	Specification for fly ash lime bricks.		
	IS:13757	Burnt clay fly ash building bricks.		
	Cast in-situ Concrete and Allied Works			
	IS:280	Mild steel wire for general engineering purpose.		
	IS:456	Code of practice for plain and reinforcement concrete.		
	IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.		
	IS:516	Method of test for strength of concrete.		
	IS:1199	Methods of sampling and analysis of concrete.		
	IS:1791	General requirement for batch type concrete mixers.		
	IS:1834	Hot applied sealing compound for joints in concrete.		
	IS:1838	Preformed fillers for expansion joints in concrete pavement and structures.		
	IS:2438	Specification for roller pan mixers.		
	IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.		
	IS:2505	Concrete vibrators - immersion type.		
	IS:2506	General requirements for screed board concrete vibrators.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).		
	IS:2750	Steel scaffoldings		
	IS:2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.		
	IS:3150	Hexagonal wire netting for general purposes.		
	IS:3366	Specification for pan vibrators.		
	IS:3370 (Part 1-4)	Code of practice for concrete structures for the storage of liquids.		
	IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.		
	IS:4014 (Part-1&2)	Code of practice for steel tubular scaffolding.		
	IS:4326	Code of practice for earth quake resistant design and construction of buildings.		
	IS:4656	Form vibrators for concrete.		
	IS:4925 IS:4990	Concrete batching and mixing plant. Plywood for concrete shuttering work.		
	IS:5256	Code of practice for sealing expansion joints in concrete lining on canals.		
	IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.		
	IS:6461	Glossary of terms relating to cement concrete.		
	IS:6494	Code of practice for water proofing of underground reservoir and swimming pools.		
	IS:6509	Code of practice for installation of joints in concrete pavements.		
	IS:7861 (Part -1&2)	Code of practice for extreme weather concreting.		
	IS:9012	Recommended practice for shotcreting.		
	IS:9103	Admixtures for concrete.		
	IS:9417	Recommendations for welding cold worked bars for reinforced concrete construction.		
	IS:10262	Recommended guidelines for concrete mix design.		
	IS:11384	Code of practice for composite construction in structural steel and concrete.		
	IS:12118	Two parts polysulphide based sealants.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:12200Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams. IS:13311Non destructive testing of concrete - methods of test. (Part 1)Ultrasonic pulse velocity. (Part 2)Rebound hammer. SP-16Design codes for reinforced concrete to IS:456-1978. SP-23Hand book of concrete mixes. SP-24Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456) SP-34Hand book on concrete reinforcement and detailing. ACI-318American Concrete Institute code for structural concrete. Precast Concrete Works SP:7National Building Code - Structural Design (Part 6/Sec.7)Prefabrication and system building and mixed / composite construction. IS:10297Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units. IS:10505Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units. IS:15658Pre-cast concrete block for paving. Masonry & Allied Works IS:1905Code of practice for structural use of unreinforced masonry. IS: 2185Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks IS:2212Code of practice for brick work. IS:2250Code of practice for preparation and use of masonry mortars. IS:2572Code of practice for construction of hollow concrete block masonry. SP:20Hand book on masonry design and construction. Sheeting Works IS:277Galvanised steel sheets (Plan & corrugated). IS:513Cold-rolled low carbon steel sheets & strips. IS:730Hook bolts for corrugated sheet roofing.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एन टी पी सी NTPC
	IS:801Code of practice for use of cold formed light gauge steel structural members in general building construction. IS:2527Code of practice for fixing rain water gutters and down pipe for roof drainage. IS:7178Technical supply condition for tapping screw. IS:8183Bonded mineral wool. IS:8869Washers for corrugated sheet roofing. IS:12093Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets. IS:12436Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation. IS:12866Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced). IS:14246Continuously pre-painted galvanised steel sheets and coils. BS:5950Code of practice for design of light gauge profiled (Part-6)steel sheeting Fabrication and Erection of Structural Steel Works IS:800Code of practice for General Construction of steel. IS:813Scheme for symbols for welding. IS:814Covered electrodes for manual metal arc welding of carbon & carbon manganese steel. IS:816Code of practice for use of metal arc welding for general construction in mild steel. IS:817Code of practice for training and testing of metal arc welders. IS:1024Welding in bridges and substructured subject to dynamic. IS:1181Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes). IS:1182Recommended practice for Radiographic examination of fusion welded butt joints in steel plates IS:1608Mechanical testing of metals - tensile testing IS:1852Rolling and Cutting Tolerances for Hot rolled steel products. IS:2016Specification for Plain washers. IS:2595Code of practice for Radiographic testing			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	IS:2629 Hot dip galvanising of iron and steel IS:3502 Steel chequered plate. IS:3613 Acceptance tests for wire flux combination for submerged arc welding. IS:3658 Code of practice for liquid penetrant flaw detection. IS:3664 Code of practice for ultra sonic pulse echo testing contact and immersion method IS:3757 High strength structural bolts. IS:4000 High strength bolts in steel structure - code of practice. IS:4353 Sub merged arc welding of mild steel and low alloy steel Recommendation IS:4759 Hot dip zinc coating on structural steel and other allied products. IS:5334 Code of practice for magnetic particle flaw detection of welds. IS:5369 General requirements for plain washers and lock washer IS : 6623 High strength structural nuts. IS:6649 Hardened and tampered washers for high strength structural bolts & nuts. IS:6911 Stainless steel plate, sheet and strip. IS:7205 Safety code for erection of structural steel. IS:7215 Tolerances for fabrication of structural steel. IS:7307 Approved test for welding procedures (Part - I) Fusion welding of steel. IS:7310 Approval test for welders working to approval welding procedure. (Part-I) Fusion welding of steel IS:9178 Criteria for design of steel bins for storage of bulk material. (Part-1to 3) IS:9595 Recommendations for metal arc welding of carbon & carbon manganese steel. IS:12843 Tolerances for erection of steel structures. SP:6 ISI Hand book for structural Engineers. (Part 1 to 7) Plastering and Allied Works IS:1661 Code of practice for application of cement and cement lime plaster finishes. IS:2402 Code of practice for external rendered finishes.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	IS:2547 Gypsum building plaster. (Parts 1&2) Acid and Alkali Resistant Lining IS:158 Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting. IS:412 Expanded metal steel sheets for general purpose. IS:4441 Code of practice for use of silica type chemical resistant mortars. IS:4443 Code of practice for use of resin type chemical resistant mortars. IS:4456 Method of Test for chemical resistant tiles. (Part I & II) IS:4457 Ceramic unglazed vitreous acid resisting tiles. IS:4832 Specification for chemical resistant mortars. (Part - 1) Silicate type (Part - 2) Resin type (Part - 3) Sulfur type IS:4860 Acid resistant bricks. IS:9510 Bitumastic acid resisting grade. Water Supply, Drainage and Sanitation IS:458 Precast concrete pipes (with & without reinforcement). IS:554 Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation. IS:651 Salt glazed stoneware pipes and fittings. IS:774 Flushing cisterns for water closets and urinals. IS:775 Cast iron brackets and supports for wash basins and sinks. IS:778 Copper alloy gate, globe and check valves for water works purposes. IS:781 Cast copper alloy screw down bib taps & stop valves for water services. IS:782 Caulking lead. IS:783 Code of practice for laying of concrete pipes. IS:1172 Code of basic requirements of water supply, drainage and sanitation. IS:1230 Cast iron rain water pipes and fittings.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 			
	IS:1239 (Part 1&2) IS:1536 IS:1537 IS:1538 IS:1703 IS:1726 IS:1729 IS:1742 IS:2064 IS:2065 IS:2326 IS:2548 IS:2556 IS:3114 IS:3311 IS:3438 IS:3486 IS:3589 IS:3989 IS:4111 (Part 1 to 5) IS:4127 IS : 4733 IS:4764 IS:1068 IS:5329 IS:5382 Mild Steel tubes, tubulars and other wrought steel fittings Centrifugally cast (Spun) iron pressure pipes for water. Vertically cast iron pressure pipes for water, gas and sewage. Cast iron fittings for pressure pipe for water, gas and sewage. Copper alloy float valve for water supply fitting. Cast iron manhole covers and frames. Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series. Code of practice for building drainage. Selection, installation and maintenance of sanitary appliances. Code of practice for water supply in buildings. Automatic flushing cisterns for urinals. Plastic seats and covers for water closets. Vitreous sanitary appliances (vitreous china). Code of practice for laying of cast iron pipes. Waste plug and its accessories for sinks and wash basins. Silvered glass mirrors for general purposes. Cast iron spigot and socket drain pipes. steel pipe for water and sewage (168.3 to 2540mm outside diameter) Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories. Code of practice for ancillary structure in sewerage system. Code of practice for laying of glazed stone ware pipes. Methods of sampling and testing sewage effluents. Tolerance limits for sewage effluents discharged into inland surface waters. Electroplated coating of nickel plus chromium and copper plus nickel plus chromium. Code of practice for sanitary pipe work above ground for buildings. Rubber sealing rings for gas mains, water mains and sewers.			
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CLAUSE NO.	एनडीपीसी NTPC TECHNICAL REQUIREMENTS		
	IS:5822 Code of practice for laying of electrically welded steel pipes for water supply. IS:5961 Specification for cast iron grating for drainage purpose. IS:7740 Code of practice for construction and maintenance of road gullies. IS:8931 Copper alloy fancy single taps combination tap assembly and stop valves for water services. IS:9762 Polyethylene floats for float valves. IS:10592 Industrial emergency showers, eye and face fountains and combination units. IS:12592 Specification for precast concrete manhole covers and frames. IS:12701 Rotational moulded polyethylene water storage tanks. IS:13983 Stainless steel sinks for domestic purposes. SP:35 Hand book on water supply and drainage with special emphasis on plumbing. CPH&EEO Manual on sewage and sewage treatment Publication - as updated. Doors Windows and Allied Works IS:204 Tower Bolts. (Part 1) Ferrous metals (Part 2) Non - ferrous metals IS:208 Door Handles. IS:281 Mild steel sliding door bolts for use with padlocks. IS:362 Parliament Hinges. IS:419 Putty, for use on window frames. IS:451 Technical supply conditions for wood screws IS:733 Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes. IS:1003 (Part I) Timber panelled and glazed shutters (doors shutters). IS:1003 (Part-1) Timber panelled and glazed shutters door shutters. IS:1038 Steel doors, windows and ventilators.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 			
	IS:1081 Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators. IS:1285 Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes). IS:1341 Steel butt hinges. IS:1361 Steel windows for Industrial buildings. IS:1823 Floor door stoppers. IS:1868 Anodic coatings on Aluminium and its alloys. IS:2202 Wooden flush door shutters (solid core type) particle board face panels and hard board face panels. (Part-2) IS:2209 Mortice locks (vertical type) IS:2553 Safety glass. (Part-1) General purposes IS:2835 Flat transparent sheet glass. IS:3548 Code of practice for glazing in buildings. IS:3564 Door closers (Hydraulically regulated) IS:3614 Specification for fire check doors : (Part-1) plate, metal covered and rolling type. (Part-2) Resistance test and performance criteria. IS:4351 Specification for steel door frames. IS:5187 Flush bolts. IS:5437 Figured, rolled and wired glass. IS:6248 Specification for metal rolling shutters and rolling grills. IS:6315 Specification for floor springs (Hydraulically regulated) for heavy doors. IS:7196 Hold fast. IS:7452 Hot rolled steel sections for doors, windows and ventilators. IS:10019 Mild steel stays and fasteners. IS:10451 Steel sliding shutters (top hung type) IS:12823 Prelaminated particle boards.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	Roof Water Proofing and Allied Works			
	IS:3067	code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.		
	ASTM	Standard specification for high solid content cold		
	C836-89a	liquid applied elastomeric water proofing membrane for use with separate wearing course.		
	ASTM	Standard guide for high solid content cold		
	C898-89	liquid applied elastomeric water proofing membrane for use with separate wearing course.		
	Floor Finishes and Allied Works			
	IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.		
	IS:8042	White portland cement.		
	IS:13755	Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).		
	IS:13801	Chequered cement concrete tiles.		
	Painting and Allied Works			
	IS:162	Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.		
	IS:428	Distemper, oil, emulsion, colour as required.		
	IS:1477	Code of practice for painting of ferrous metals in buildings.		
	(Part -1)	Pretreatment.		
	(Part -2)	Painting.		
	IS:1650	Specification for colours for building and decorative materials.		
	IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.		
	IS:2338	Code of practice for finishing of wood and wood based materials.		
	(Part -1)	Operations and Workmanship.		
	(Part -2)	Schedule.		
	IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.		
	(Part-1)	Operations and Workmanship.		
	(Part -2)	Schedule.		
IS:2524	Code of practice for painting of nonferrous metals in buildings.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC			
	(Part -1) Pretreatment (Part -2) Painting. IS:2932 Enamel, synthetic, exterior, (a) under coating and (b) finishing. IS:2933 Enamel exterior, (a) under coating, (b) finishing. IS:4759 Hot dip zinc coatings on structural steel and other allied products. IS:5410 Specification for cement paint. IS:15489 Plastic emulsion paint. IS:6278 Code of practice for white washing and Colour washing. IS:10403 Glossary of term related to building finish. IS:12027 Silicone based water repellent IS:13238 Epoxy based zinc phosphate primer (2 pack) IS:13239 Epoxy surfacer (2 pack) IS:13467 Chlorinated rubber for paints IS:14209 Epoxy enamel, two component glossy. BS:5493 Code of practice for protective coating of iron and steel structures against corrosion. Piling and Foundation IS:1080 Code of practice for design and construction of shallow foundations on soils. IS:1904 Code of practice for design and construction of foundation in Soils : General Requirements. IS:2314 Steel sheet piling sections. IS:2911 Code of practice for design and construction of pile foundations. (Relevant Parts) IS:2950 Code of practice for designs and construction of Raft foundation. (Part-1) Design IS:2974 Code of practice for design and construction of machine foundation. (Part-1 to 5) IS:4091 Code of practice for design and construction foundations for transmission line towers and poles. IS:6403 Code of practice for determination of Bearing capacity of Shallow foundations. IS:8009 Code of practice for calculation of settlement of foundation.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(Part -1)	Shallow foundations.		
	(Part -2)	Deep foundations.		
	IS:12070	Code of practice for design and construction of shallow foundations on rocks.		
	VIN:2056	Criteria for assessing mechanical vibrations of machines.		
	VDI:2060	Criteria for assessing the st of balance of rotating rigid bodies.		
	DIN:2089	Helical compression spring made of round wire and rod : calculation and design of compression .		
	DIN:2096	Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.		
	DIN:4024	Flexible supporting structures for machine with rotating machines.		
	Roads			
	IRC:5 (Section-1)	Standard specifications and Code of practice for road bridges, General Features of Design.		
	IRC:14	Recommended practice for 2cm thick bitumen and tar carpets.		
	IRC:15	Standard specifications and code of practice for construction of concrete roads.		
	IRC:16	Specification for priming of base course with bituminous primers.		
	IRC:19	Standard specifications and Code of practice for water bound macadam.		
	IRC:21 (Section-III)	Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).		
	IRC:34	Recommendations for road construction in water logged areas.		
	IRC:36	Recommended practice for the construction of earth embankments for road works.		
	IRC:37	Guidelines for the Design of flexible pavements.		
	IRC:56	Recommended practice for treatment of embankment slopes for erosion control.		
	IRC:58	Guidelines for the design of rigid pavements for highways.		
	IRC:73	Geometric Design standards for rural (non-urban) highways.		
	IRC : 86	Geometric Design standards for urban roads in plains.		
	IRC:SP:13	Guidelines for the design of small bridges & culverts.		
	IRC -	Ministry of Surface Transport (Road wing),		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एन टी पी सी NTPC
	Publication	specifications for road and bridge works.		
	IS:73	Paving bitumen.		
	Loading			
	IS:875	Code of practice for design loads (other than earthquake) for (Relevant parts) buildings and structures.		
	IS:1893	Criteria for earthquake resistant design of structures.		
	IS:4091	Code of practice for design and construction of foundation for transmission line towers and poles.		
	IRC:6 (Section-II)	Standard specifications & Code of practice for road bridges. loads and stresses		
	Safety			
	IS:1641	Code of practice for fire safety of buildings - General principles of fire grading and classification.		
	IS:1642	Code of practice for fire safety of buildings - Details of construction.		
	IS:3696 (Part-1&2)	Safety code for scaffolds and ladders.		
	IS:3764	Excavation work - code of safety.		
	IS:4081	Safety code for blasting and related drilling operations.		
	IS:4130	Demolition of buildings - code of safety.		
	IS:5121	Safety code for piling and other deep foundations.		
	IS:5916	Safety code for construction involving use of hot bituminous materials.		
	IS:7205	Safety code for erection of structural steel work.		
	IS:7293	Safety code for working with construction machinery.		
	IS:7969 Indian Explosives Act 1940)	Safety code for handling and storage of building materials. (As updated)		
	Architectural Design of Buildings			
	SP:7	National Building Code of India		
	SP:41	Hand book on functional requirements of buildings (other than industrial buildings)		
	ECBC	Energy Conservation Building Code		
	GRIHA	Green Rating For Integrated Habitat Assessment.		
KHARGONE STPP (2X660MW) EPC PACKAGE		TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 231 OF 393

CLAUSE NO.	एनटीपीसी NTPC TECHNICAL REQUIREMENTS		
	Chimney IS:4998 Criteria for design of reinforced chimneys IS:6533 Code of practice for design and construction of steel chimneys ICAO International Civil Aviation Organisation (ICAO) DGCA Instruction of Director General of Civil Aviation , India ACI:307 Specification for the design and construction of reinforced concrete chimneys BS:4076 Specification for steel chimneys CICIND Model Code for concrete chimneys Model code for steel chimneys ASCE Code Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975. IS:1554 PVC insulated (heavy duty) electric cables IS:2606 Alloy lead anodes for chromium plating IS:3043 Code of Practice for Earthing IS:9537 Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act IS:2309 Practice for protection of buildings and allied structures against lightning Miscellaneous IS:802 Code of practice for use of structural steel in overhead trans- (Relevant parts) mission line towers. IS:803 Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks. IS:10430 Criteria for design of lined canals and guidance for selection of type of lining. IS:11592 Code of practice for selection and design of belt conveyors. IS:12867 PVC handrails covers. IS 11504 Criteria for structural design of reinforced concrete natural draught cooling towers BS:4485 (IV) British Standard : Code of design for water cooling towers CIRIA Design and construction of buried thin-wall pipes. Publication IS 4671 Expanded polystyrene for thermal insulation purposes.		
KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 232 OF 393

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	ANNEXURE (b) CONSTRUCTION METHODOLOGY Construction and erection activities shall be fully mechanised from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer. For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed. Dewatering shall be done using the combination of electrical and standby diesel pumps. Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles. For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used. All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used. All handling of materials shall be with cranes. Heavy trailers shall be used for transportation. Mechanized modular units of scaffolding and shuttering shall be used. Grouting shall be carried out using hydaulically controlled grouting equipment. Roadwork shall be done using pavers, rollers and premix plant. All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted. Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used. Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed. All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.		
KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 233 OF 393

BORE HOLE DATA

CLIENT : NTPC LIMITED													
PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.													
SHEET NO. : 1 OF 2					DATE : 20/04/2011 To 24/04/2011								
BORE HOLE NO: BH-13					METHOD : ROTARY DRILLING								
LOCATION : --					CASING : Up to 2.50m BGL								
CO-ORDINATES: E-587900, N-2440400					DIAMETER : 100mm & NX								
REDUCED LEVEL : --					GROUND W. T. : NMW								
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Brown silty Sand	1.00									
2.00				2.50	CORE					15	NIL		
3.00				4.00	CORE					22	NIL		
4.00				5.50	CORE					30	NIL		
5.00				7.00	CORE					35	NIL		
6.00			Grey Fractured basalt	8.50	CORE					40	10		
7.00				10.00	CORE					41	08		
8.00													
9.00													
10.00													

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 20/04/2011 To 24/04/2011

BORE HOLE NO: BH-13

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-587900, N-2440400

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15			
11.00		▽			CORE				40	NIL	
12.00		▽		11.50	CORE				45	15	
13.00		▽		13.00	CORE				60	50	
14.00	NX	▽	Grey Basalt	14.50	CORE				65	53	
15.00		▽		16.00	CORE				60	55	
16.00		▽		17.00	CORE				67	60	
17.00		▽		18.00	CORE						

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

19.00

30.00

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2	DATE : 24/04/2011 To 28/04/2011
BORE HOLE NO: BH-14	METHOD : ROTARY DRILLING
LOCATION : -	CASING : Up to 3.0m BGL
CO-ORDINATES: E-588100, N-2440400	DIAMETER : 100m m & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Brown silty sand									
2.00				1.50/ 2.10	SPT1	05	09	13	5	22		
3.00				3.00/ 3.10	SPT2	55	--	--	--	R		
4.00			Grey fractured Basalt	4.50	CORE					18	NIL	
5.00				5.50	CORE					13	NIL	
6.00				6.00	CORE					14	NIL	
7.00				7.50	CORE					10	NIL	
8.00				8.50	CORE					30	NIL	
9.00					CORE							
10.00				10.00	CORE							

SPT N =STANDARD PENETRATION TEST VALUE
 UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
 JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 24/04/2011 To 28/04/2011

BORE HOLE NO: BH-14

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.0m BGL

CO-ORDINATES: E-588100, N-2440400

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
11.00	NX	▽	Grey Basalt		CORE						27	07	
11.50				11.50									
12.00				12.00	CORE						50	39	909
					CORE						90	58	
13.00				13.00									
14.00				14.20	CORE						83	62	619
15.00		▽		15.50	CORE						70	50	487
16.00		▽			CORE						83	60	
17.00		▽		17.00									

BORE HOLE IS TERMINATED AT 17.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 17.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 24/04/2011 To 28/04/2011

BORE HOLE NO.: BH-15

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-588300, N-2440400

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm			1.00									
2.00			Silty Sand mixed with boulders	2.50	CORE						15	NIL	
3.00				4.00	CORE						20	NIL	
4.00				5.50	CORE						25	NIL	
5.00	NX			7.00	CORE						28	NIL	
6.00			Grey weathered Basalt	8.50	CORE						35	NIL	
7.00				10.00	CORE						40	10	945
8.00			Grey fractured Basalt										
9.00													
10.00													

SPT N =STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 24/04/2011 To 28/04/2011

BORE HOLE NO: BH-15

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-588300, N-2440400

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
11.00	NX	▽	Grey Basalt		CORE						50	12	
11.50		▽		11.50									
12.00		▽			CORE						52	15	626
13.00		▽		13.00									
14.00		▽			CORE						65	55	
14.50		▽		14.50									
15.00		▽			CORE						63	62	
15.50		▽		15.50									
16.00		▽			CORE						60	55	939
17.00		▽		17.00									
18.00		▽		18.00	CORE						65	60	
18.50		▽		18.50									
19.00													
20.00													
21.00													
22.00													
23.00													
24.00													
25.00													
26.00													
27.00													
28.00													
29.00													
30.00													

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO.: 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 29/04/2011 To 02/05/2011

BORE HOLE NO: BH-16

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm			1.00									
2.00			Silty Sand mixed with boulders	2.00	CORE						10	NIL	
3.00				3.00	CORE						15	NIL	
4.00					CORE						22	NIL	
5.00	NX		Grey weathered Basalt	4.50									
6.00				6.00	CORE						30	NIL	
7.00					CORE						35	NIL	
8.00				7.50									
9.00			Grey Fractured Basalt		CORE						40	10	839
				9.00									
10.00					CORE						43	NIL	
				10.00									

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO.: 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 29/04/2011 To 02/05/2011

BORE HOLE NO.: BH-16

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
11.00		▽	Grey Basalt								45	NIL	
		▽		11.50									
12.00		▽									50	15	623
		▽		13.00									
13.00		▽									60	51	
14.00	NX	▽		14.50									
15.00		▽									63	55	764
16.00		▽		16.00									
17.00		▽		17.00							63	55	
18.00		▽		18.00							70	65	

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 04/07/2011 To 15/07/2011

BORE HOLE NO.: BH-17

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587900, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Silty sand mixed with Boulders	1.00							05	NIL	
2.00				2.00							08	NIL	
3.00			Grey fractured Basalt	3.00							24	NIL	
4.00	NX			4.50							23	09	668
5.00											30	17	
6.00				6.00									
7.00				7.50							32	17	
8.00											33	18	463
9.00				9.00									
10.00											33	17	

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 04/07/2011 To 15/07/2011

BORE HOLE NO: BH-17

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587900, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15			
				10.50	CORE				33	17	
11.00					CORE				37	20	
12.00				12.00							
					CORE				40	27	981
13.00			Grey Basalt	13.50							
14.00	NX				CORE				55	55	
15.00				15.00							
					CORE				57	57	
16.00				16.50							
					CORE				59	59	
17.00				18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED														
PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed														
SHEET NO. : 1 OF 2						DATE : 07/07/2011 To 20/07/2011								
BORE HOLE NO.: BH-18						METHOD : ROTARY DRILLING								
LOCATION : --						CASING : Up to 3.00m BGL								
CO-ORDINATES: E-588100, N-2440200						DIAMETER : 100m m & NX								
REDUCED LEVEL : --						GROUND W. T. : NMW								
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)	
				DEPTH (m)	TYPE	15	15	15	15					
1.00	100 mm		Silty sand mixed with boulders	1.00							08	NIL		
2.00				2.00								10	NIL	
3.00			Grey Fractured Basalt	3.00							25	NIL		
4.00	NX			4.50								25	NIL	
5.00				6.00								28	NIL	
6.00			Grey Basalt	7.00							27	13	1224	
7.00				7.50										
8.00				9.00								32	17	551
9.00											30	24		
10.00														

SPT N - STANDARD PENETRATION TEST VALUE
 UDS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.
 SCALE : 1: 50
 JOB NO. : 0300

CLIENT : NTPC LIMITED									
PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed									
SHEET NO. : 2 OF 2					DATE : 07/07/2011 To 20/07/2011				
BORE HOLE NO.: BH-18					METHOD : ROTARY DRILLING				
LOCATION : --					CASING : Up to 3.00m BGL				
CO-ORDINATES: E-588100, N-2440200					DIAMETER : 100m m & NX				
REDUCED LEVEL : --					GROUND W. T. : NMW				

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
		▽▽▽		10.50	CORE						30	24	
11.00		▽▽▽			CORE						37	28	1202
12.00		▽▽▽		12.00									
13.00		▽▽▽			CORE						39	29	
14.00	NX	▽▽▽	Grey Basalt	13.50									
15.00		▽▽▽			CORE						55	55	
16.00		▽▽▽			CORE						55	55	
17.00		▽▽▽											
18.00		▽▽▽		18.00	CORE						60	60	
BORE HOLE IS TERMINATED AT 18.00 M. BGL.													
19.00													
30.00													

SPT N = STANDARD PENETRATION TEST VALUE
 UDS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.
 SCALE : 1: 50
 JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 02/05/2011 To 07/05/2011

BORE HOLE NO.: BH-19

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.50m BGL

CO-ORDINATES: E-588300, N-2440200

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Black cotton soil									
2.00				1.50/ 2.10	SPT1	04	05	06	11			
2.50												
3.00										10	NIL	
4.00										15	NIL	
5.00			Grey fractured basalt							40	NIL	
6.00	NX									30	07	
7.00										33	13	1106
8.00			Grey Basalt							43	20	
9.00												
10.00												

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 02/05/2011 To 07/05/2011

BORE HOLE NO: BH-19

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.5 m BGL

CO-ORDINATES: E-588300, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15			
11.00		▽			CORE				45	17	1008
11.50		▽									
12.00		▽			CORE				46	23	
13.00		▽									
14.00	NX	▽	Grey Basalt		CORE				57	53	1258
14.50		▽									
15.00		▽			CORE				63	53	
16.00		▽									
16.50		▽			CORE				65	65	
17.00		▽									
17.50		▽			CORE				65	52	
18.00		▽									

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 06/05/2011 To 10/05/2011

BORE HOLE NO.: BH-20

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588500, N-2440200

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Black cotton soil										
2.00				1.50/ 2.00	SPT1	05	08	15	5	23			
3.00				3.00							30	NIL	
4.00				4.50							37	NIL	
5.00											40	08	
6.00	NX		Grey Basalt	6.00							45	28	
7.00				7.50							41	19	
8.00											47	23	
9.00				9.00									
10.00													

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 06/05/2011 To 10/05/2011

BORE HOLE NO: BH-20

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.0m BGL

CO-ORDINATES: E-588500, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
				10.50	CORE				47	23	
11.00					CORE				48	30	
12.00				12.00							
					CORE				56	50	
13.00											
				13.50							
14.00	NX		Grey Basalt		CORE				57	57	
15.00				15.00							
					CORE				60	55	
16.00											
				16.50							
17.00					CORE				68	61	
18.00				18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2	DATE : 08/05/2011 To 12/05/2011
BORE HOLE NO: BH-21	METHOD : ROTARY DRILLING
LOCATION : --	CASING : Up to 2.50m BGL
CO-ORDINATES: E-588700, N-2440200	DIAMETER : 100m m & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SCCM)
				DEPTH (m)	TYPE	15	15	15					
1.00	100 mm		Silty sand mixed with boulders	1.00									
2.00				2.50							05	NIL	
3.00			Gassy fractured Basalt	4.00							17	NIL	
4.00				5.50							23	NIL	
5.00				7.00							27	NIL	
6.00				8.50							37	NIL	
7.00													
8.00													
9.00													
10.00													

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 08/05/2011 To 12/05/2011

BORE HOLE NO.: BH-21

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-588700, N-2440200

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽			CORE					42	16	1167
11.50		▽										
12.00		▽			CORE					47	08	
13.00		▽		13.00								
14.00	NX	▽	Grey Basalt		CORE					53	53	1392
14.50		▽										
15.00		▽			CORE					60	53	
16.00		▽		16.00								
17.00		▽		17.00	CORE					65	65	1205
18.00		▽		18.00	CORE					69	69	

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 24/05/2011 To 29/05/2011

BORE HOLE NO.: BH-22

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-588900, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Silty sand mixed with boulders	1.00									
2.00											25	NIL	
2.50													
3.00			Green Fractured Basalt										
4.00				4.00							25	NIL	
5.00											30	NIL	
5.50				5.50									
6.00	NX		Green Fractured Basalt								40	NIL	
7.00				7.00									
8.00											45	10	616
8.50				8.50									
9.00			Green Fractured Basalt								43	NIL	
10.00				10.00									

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 24/05/2011 To 29/05/2011

BORE HOLE NO.: BH-22

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-588900, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽								40	NIL	
		▽		11.50								
12.00		▽								45	10	
		▽		13.00								
13.00		▽										
		▽		14.00						55	51	743
14.00	NX	▽	Grey Basalt	14.50								
		▽		15.00						60	55	
15.00		▽		15.50								
		▽		16.00						65	60	
16.00		▽		17.00								
		▽		17.50						75	70	
17.00		▽		18.00								
		▽										
18.00		▽										
		▽										
19.00		▽										
		▽										
20.00		▽										
		▽										
21.00		▽										
		▽										
22.00		▽										
		▽										
23.00		▽										
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24.00		▽										
		▽										
25.00		▽										
		▽										
26.00		▽										
		▽										
27.00		▽										
		▽										
28.00		▽										
		▽										
29.00		▽										
		▽										
30.00		▽										

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 23/05/2011 To 29/05/2011

BORE HOLE NO.: BH-23

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589100, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Silty sand mixed with boulders	1.00								
2.00										7	NIL	
2.50												
3.00			Grey fractured Basalt									
4.00				4.00					CORE	30	NIL	
5.00	NX											
5.50				5.50					CORE	33	NIL	
6.00												
7.00				7.00					CORE	40	08	
8.00												
8.50				8.50					CORE	43	16	1239
9.00												
10.00									CORE	40	NIL	
				10.00								

SPT N =STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 23/05/2011 To 29/05/2011

BORE HOLE NO.: BH-23

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589100, N-2440200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15				
11.00		▽			CORE				35	07	
12.00		▽		11.50	CORE				31	08	
13.00		▽		13.00							
14.00		▽	Grey Basalt		CORE				53	51	2083
15.00	NX	▽		14.50							
16.00		▽			CORE				55	55	
17.00		▽		16.00							
		▽			CORE				70	70	1037
		▽		17.50							

BORE HOLE IS TERMINATED AT 17.50 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 17.50 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Dist. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 08/07/2011 To 15/07/2011

BORE HOLE NO.: BH-24

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-587700, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm	+	Completely Weathered ROCK								05	NIL	
2.00		+		1.50/ 1.70	SPT1	25	50	--	--	R			
3.00		+		3.00/ 05	PT2	55	--	--	--	R	07	NIL	
4.00		+		4.50/ 4.57	SPT3	51	--	--	--	R	07	NIL	
5.00	NX	+	Brown Basalt								08	NIL	
6.00		+		6.00/ 6.05	SPT4	55	--	--	--	R			
7.00		+		7.50	CORE						30	NIL	
8.00		+		9.00	CORE						29	16	461
9.00		+			CORE						36	17	
10.00		+											

SPT N =STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 08/07/2011 To 15/07/2011

BORE HOLE NO.: BH-24

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-587700, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15				
		▽		10.50	CORE					36	17	
11.00		▽										
		▽			CORE					39	25	727
12.00		▽		12.00								
		▽			CORE					45	36	
13.00		▽		13.00								
		▽			CORE					56	56	418
14.00	NX	▽	Brown Basalt	14.50								
		▽			CORE					63	63	
15.00		▽										
16.00		▽		16.00								
		▽			CORE					56	56	
17.00		▽		17.00								
		▽			CORE					65	65	
18.00		▽		18.00								

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 02/07/2011 To 09/07/2011

BORE HOLE NO.: BH-25

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.00m BGL

CO-ORDINATES: E-587900, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15	15						
1.00	100 mm	+	Completely weathered rock										08	NIL	
2.00		+		1.50/ 1.75	SPT1	25	51	--	--	--	R				
3.00		+											07	NIL	
4.00		+		3.40/ 3.10	SPT2	55	--	--	--	--	R				
5.00		+		4.50/ 5.55	SPT3	51	--	--	--	--	R				
6.00	NX	+	Grey fractured Basalt	6.00/ 6.05	SPT4	50	--	--	--	--	R				
7.00		▽		7.50	CORE							23	08	589	
8.00		▽		9.00	CORE							25	17		
9.00		▽			CORE							35	16		
10.00		▽			CORE										

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 02/07/2011 To 09/07/2011

BORE HOLE NO.: BH-25

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.00m BGL

CO-ORDINATES: E-587900, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
		▽		10.50	CORE				35	16	
11.00		▽									
		▽									
		▽									
12.00		▽		12.00	CORE				43	25	856
		▽									
		▽									
13.00		▽							45	30	
		▽									
		▽		13.50	CORE						
14.00	NX	▽	Grey Basalt								
		▽									
		▽									
15.00		▽		15.00	CORE				60	60	972
		▽									
		▽									
16.00		▽							54	54	
		▽		16.00	CORE						
		▽									
17.00		▽									
		▽									
		▽									
18.00		▽		18.00	CORE				59	59	
		▽									
		▽									
19.00		▽									
		▽									
		▽									
20.00		▽									
		▽									
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21.00		▽									
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22.00		▽									
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28.00		▽									
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		▽									
29.00		▽									
		▽									
		▽									
30.00		▽									

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 12/05/2011 To 17/05/2011

BORE HOLE NO.: BH-26

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588100, N-2440000

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
0.50	100 mm		Black cotton soil										
1.00											30	NIL	
1.50													
2.00			Silty sand mixed with boulders								24	NIL	
3.00													
4.00											30	NIL	
4.50													
5.00											35	NIL	
6.00	NX												
6.50			Grey Fractured Basalt								33	12	
7.00													
7.50													
8.00											35	NIL	778
9.00													
9.50											30	NIL	
10.00													

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 12/05/2011 To 17/05/2011

BORE HOLE NO: BH-26

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588100, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15			
10.50		▽	Grey Basalt		CORE				30	NIL	
11.00		▽			CORE				40	10	
12.00		▽		12.00							
13.00		▽			CORE				50	15	
14.00	NX	▽		13.50							
15.00		▽			CORE				61	52	655
16.00		▽		15.00					60	55	
16.50		▽			CORE						
17.00		▽		16.50							
18.00		▽			CORE				65	60	
18.00		▽		18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 08/05/2011 To 14/05/2011

BORE HOLE NO.: BH-27

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.0m BGL

CO-ORDINATES: E-588300, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Black cotton soil										
2.00				1.50/ 2.10	SPT1	04	01	06	08	11			
3.00													
4.00	NX		Completely weathered rock	4.00/ 4.6	SPT2	15	20	55	--	R			
5.00				4.50/ 4.75	SPT3	16	51	--	--	R			
6.00													
7.00			Brown weathered Basalt								20	NIL	
8.00													
9.00													
10.00			Grey Basalt								33	10	262

SPT N - STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 08/05/2011 To 14/05/2011

BORE HOLE NO: BH-27

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.0m BGL

CO-ORDINATES: E-588300, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
11.00		▽		11.00	CORE				33	10	
12.00		▽		12.50	CORE				43	15	
13.00		▽		14.00	CORE				50	40	1148
14.00	NX	▽	Grey Basalt	15.50	CORE				51	51	
15.00		▽		16.50	CORE				60	54	1225
16.00		▽		18.00	CORE				57	57	
17.00		▽									
18.00		▽									

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N -STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 23/05/2011 To 26/05/2011

BORE HOLE NO.: BH-28

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588700, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Black cotton soil	1.00									
2.00			Silty sand mixed with Boulders	2.00		CORE					15	NIL	
3.00				3.00		CORE					14	NIL	
4.00			Grey Fractured Basalt	4.50		CORE					30	NIL	1119
5.00						CORE					33	NIL	
6.00				6.00		CORE					40	NIL	
7.00				7.50		CORE					39	NIL	1268
8.00				9.00		CORE					40	NIL	
9.00				10.00		CORE							
10.00													

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED										
PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.										
SHEET NO. : 2 OF 2					DATE : 23/05/2011 To 26/05/2011					
BORE HOLE NO.: BH-28					METHOD : ROTARY DRILLING					
LOCATION : --					CASING : Up to 3.00m BGL					
CO-ORDINATES: E-588700, N-2440000					DIAMETER : 100m m & NX					
REDUCED LEVEL : --					GROUND W. T. : NMW					
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE DEPTH (m)	BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)	
11.00		▽		11.50			45	NIL		
12.00		▽		12.00			47	15	464	
13.00		▽		14.00			61	55		
14.00	NX	▽	Grey Basalt	14.50			65	57		
15.00		▽		16.00			67	60		
16.00		▽		17.00			70	65		
17.00		▽		18.00						
18.00		▽								
19.00										
30.00										
BORE HOLE IS TERMINATED AT 18.00 M. BGL.										
SPT N = STANDARD PENETRATION TEST VALUE CR = CORE RECOVERY UDS = UNDISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION										
REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS								SCALE : 1: 50		
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.								JOB NO. : 0300		

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2	DATE : 30/05/2011 To 03/06/2011
BORE HOLE NO: BH-29	METHOD : ROTARY DRILLING
LOCATION : --	CASING : Up to 2.50m BGL
CO-ORDINATES: E-589100, N-2440000	DIAMETER : 100m m & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15					
1.00	100 mm		Silty Sand	1.00									
2.00				2.50							20	NIL	
3.00				4.00							30	NIL	
4.00				5.50							33	NIL	
5.00			Grey fractured basalt	7.00							40	NIL	
6.00	NX			8.50							42	12	1055
7.00				10.00							45	10	

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 30/05/2011 To 03/06/2011

BORE HOLE NO.: BH-29

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589100, N-2440000

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SCCM)
				DEPTH (m)	TYPE	15	15	15			
11.00		▽			CORE				40	13	1061
11.50		▽									
12.00		▽			CORE				45	20	
13.00	NX	▽		13.00							
14.00		▽	Grey Basalt		CORE				63	55	1280
14.50		▽									
15.00		▽			CORE				60	53	
16.00		▽		16.00							
17.00		▽			CORE				65	60	
17.00		▽		17.00							
18.00		▽			CORE				68	65	
18.00		▽		18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 02/07/2011 To 09/07/2011

BORE HOLE NO.: BH-30

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2439800

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Silty sand										
2.00				1.50/ 2.10	SPT1	09	07	15	20	33			
3.00				3.00/ 3.50	SPT1	55	--	--	--	R			
4.00			Completely weathered rock	4.50	CORE						05	NIL	
5.00				6.00	CORE						07	NIL	
6.00	NX			6.00/ 6.05	SPT3	50	--	--	--	R			
7.00				7.50	CORE						08	NIL	
8.00			Grey Basalt	9.00	CORE						10	NIL	
9.00					CORE						47	39	
10.00					CORE								

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 02/07/2011 To 09/07/2011

BORE HOLE NO.: BH-30

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2439800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
		▽		10.50	CORE					47	39	
11.00		▽			CORE					42	37	
12.00		▽		12.00	CORE					50	30	
13.00	NX	▽		13.00	CORE					60	57	
14.00		▽	Grey basalt	14.50	CORE					65	60	
15.00		▽		16.00	CORE					57	57	
16.00		▽		17.00	CORE					63	63	
17.00		▽		18.00	CORE							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2	DATE : 27/06/2011 To 04/07/2011
BORE HOLE NO: BH-31	METHOD : ROTARY DRILLING
LOCATION : --	CASING : Up to 3.00m BGL
CO-ORDINATES: E-587900, N-2439800	DIAMETER : 100mm & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm												
2.00			Silty sand	1.50/ 1.80	SPT1	15	25	55		R			
3.00				3.00									
4.00				3.00/ 3.00	SPT2	51	--	--	--	R			
4.50											08	NIL	
5.00													
6.00			Completely weathered rock	6.00/ 6.00/ 6.07	SPT3	50	--	--	--	R			
7.00											10	NIL	
8.00				7.50									
9.00				8.50							09	NIL	
10.00											12	NIL	

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2	DATE : 27/06/2011 To 04/07/2011
BORE HOLE NO: BH-31	METHOD : ROTARY DRILLING
LOCATION : --	CASING : Up to 3.00m BGL
CO-ORDINATES: E-587900, N-2439800	DIAMETER : 100mm & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽			CORE					43	25	779
11.50		▽		11.50								
12.00		▽			CORE					50	40	
13.00		▽		13.00								
14.00	NX	▽	Grey Basalt		CORE					57	53	418
14.50		▽		14.50								
15.00		▽			CORE					58	58	
15.50		▽		15.50								
16.00		▽			CORE					61	61	
16.50		▽		16.50								
17.00		▽			CORE					63	58	863
17.50		▽		17.50								
18.00		▽		18.00								

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 18/05/2011 To 22/05/2011

BORE HOLE NO.: BH-32

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 5.50m BGL

CO-ORDINATES: E-588100, N-2439800

DIAMETER : 100mm m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SQCM)
				DEPTH (m)	TYPE	15	15	15	15	15	15				
1.00	100 mm														
2.00			Black cotton soil	1.50/ 2.10	SPT1	04	04	04	04	04	04	09			
3.00				3.00/ 3.60	SPT2	03	07	09	12	16					
4.00			Silty Sand	4.50/ 5.10	SPT3	05	09	10	12	19					
5.00															
6.00				6.00/ 6.10	SPT4	51	--	--	--	R					
7.00			Completely weathered rock	7.50/ 7.60	SPT5	55	--	--	--	R					
8.00															
9.00			Grey fractured Basalt							CORE		33	NIL		
10.00				9.50						CORE		43	NIL		

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2	DATE : 18/05/2011 To 22/05/2011
BORE HOLE NO.: BH-32	METHOD : ROTARY DRILLING
LOCATION : -	CASING : Up to 5.5m BGL
CO-ORDINATES: E-588100, N-2439800	DIAMETER : 100m m & NX
REDUCED LEVEL : --	GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SGCM)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽		11.00	CORE					43	NIL	
12.00		▽		12.50	CORE					47	08	839
13.00		▽		13.50	CORE					42	10	
14.00	NX	▽	Grey fractured basalt	15.00	CORE					57	57	939
15.00		▽		16.50	CORE					56	56	789
16.00		▽		18.00	CORE					60	60	979
17.00		▽										
18.00		▽										

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED													
PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.													
SHEET NO. : 1 OF 2							DATE : 10/05/2011 To 16/05/2011						
BORE HOLE NO.: BH-33							METHOD : ROTARY DRILLING						
LOCATION : -							CASING : Up to 3.00 m BGL						
CO-ORDINATES: E-588300, N-2439800							DIAMETER : 100m m & NX						
REDUCED LEVEL : --							GROUND W. T. : NMW						
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Black cotton soil										
2.00				1.50/2.10	SPT1	01	03	05	06	08			
2.50													
3.00													
4.00													
4.00													
5.00													
5.00													
5.50			Grey weathered Basalt	5.50									
6.00													
7.00													
7.00													
8.00													
8.50													
9.00			Grey Fractured Basalt										
10.00													
10.00													

PAGED DELETED

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CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 10/05/2011 To 16/05/2011

BORE HOLE NO.: BH-33

METHOD : ROTARY DRILLING

LOCATION :

CASING : Up to 3.00 m BGL

CO-ORDINATES: E-588300, N-2439800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽			CORE					36	12	
12.00		▽		11.50								
13.00		▽			CORE					40	27	1439
14.00	NX	▽	Grey Basalt	13.00								
15.00		▽		14.50	CORE					53	53	
16.00		▽			CORE					60	60	686
17.00		▽		16.00								
		▽			CORE					65	65	
		▽		17.00								
		▽			CORE					75	75	687
		▽		18.00								

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 30/05/2011 To 03/06/2011

BORE HOLE NO.: BH-34

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588900, N-2439800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Brown silty Sand									
2.00				1.50/ 1.90	SPT1	08	17	51	R			
3.00										27	NIL	
4.00										31	NIL	
5.00												
6.00	NX		Grey Fractured Basalt							33	NIL	
7.00												
8.00										37	NIL	
9.00										36	NIL	
10.00										32	08	1559

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UCS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 30/05/2011 To 03/06/2011

BORE HOLE NO.: BH-34

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.0m BGL

CO-ORDINATES: E-588900, N-2439800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
11.00		▽		11.00	CORE				32	08	
12.00		▽		12.50	CORE				40	15	
13.00		▽		13.50	CORE				52	22	
14.00	NX	▽	Grey Basalt	15.00	CORE				53	53	1555
15.00		▽		16.50	CORE				65	59	
16.00		▽		18.00	CORE				70	61	735
17.00		▽									
18.00		▽									
19.00		▽									
20.00		▽									
21.00		▽									
22.00		▽									
23.00		▽									
24.00		▽									
25.00		▽									
26.00		▽									
27.00		▽									
28.00		▽									
29.00		▽									
30.00		▽									

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
RDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 31/05/2011 To 08/06/2011

BORE HOLE NO.: BH-35

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589300, N-2439800

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
	100 mm		Brown silty Sand	0.50									
1.00		+									07	NIL	
2.00		+		1.50/ 1.75	SPT1	30	5	--	--				
		+									10	NIL	
3.00		+		2.00/ 3.00	SPT2	51	--	--	--	R			
4.00	NX	+	Completely weathered rock								08	NIL	
		+		4.50/ 4.65	SPT3	51	--	--	--	R			
5.00		+									07	NIL	
6.00		+		6.00/ 6.05	SPT4	51	--	--	--	R			
7.00		+									05	NIL	
		+		7.50/ 7.55	SPT5	55	--	--	--	R			
8.00		+											
		+									25	NIL	
9.00		+		9.00									
		▽	Grey fractured basalt								31	09	735
10.00		▽											

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 31/05/2011 To 08/06/2011

BORE HOLE NO.: BH-35

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589300, N-2439800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15			
				10.50	CORE				31	09	
11.00					CORE				37	21	
12.00				12.00							
					CORE				40	25	861
13.00			Grey Basalt	13.50							
14.00	NX				CORE				57	53	
15.00				15.00							
					CORE				67	58	1103
16.00				16.50							
17.00					CORE				70	53	
18.00				18.00							
BORE HOLE IS TERMINATED AT 18.00 M. BGL.											
19.00											
30.00											
SPT N = STANDARD PENETRATION TEST VALUE						CR = CORE RECOVERY					
UDS = UNDISTURBED SOIL SAMPLE						RQD = ROCK QUALITY DESIGNATION					
REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS										SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0300	

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 25/06/2011 to 02/07/2011

BORE HOLE NO.: BH-36

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Silty Sand										
2.00				1.50/ 1.55	SPT1	05	--	--	--	N			
3.00											30	NIL	
4.00											25	NIL	
5.00													
6.00	NX		Grey Fractured Basalt	6.00							30	15	
7.00											33	17	1028
8.00													
9.00				9.00							37	20	
10.00											38	28	689

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 25/06/2011 to 02/07/2011

BORE HOLE NO.: BH-36

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587700, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL :

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
				10.50	CORE				38	28	
11.00											
					CORE				40	24	
12.00				12.00							
					CORE				43	23	603
13.00											
			Grey Basalt	13.50							
14.00					CORE				56	50	
15.00				15.00							
					CORE				57	57	
16.00											
				16.50							
17.00					CORE				61	61	
18.00				18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 23/06/2011 to 02/07/2011

BORE HOLE NO.: BH-37

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587900, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Brown Silty Sand									
2.00				1.50/ 1.70	SPT1	35	51	--	R			
2.50												
3.00	NX		Grey Fractured Basalt							23	NIL	
4.00				4.00								
5.00										25	09	
5.50				5.50								
6.00	NX		Grey Fractured Basalt							29	15	1146
7.00				7.00								
8.00										30	17	
8.50				8.50								
9.00	NX		Grey Fractured Basalt							35	23	
10.00				10.00								

SPT N =STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 23/06/2011 to 02/07/2011

BORE HOLE NO.: BH-37

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587900, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽								37	22	
		▽										
		▽										
		▽										
12.00		▽								41	21	1015
		▽										
		▽										
13.00		▽										
		▽										
		▽										
14.00	NX	▽	Grey Basalt							55	55	
		▽										
		▽										
15.00		▽								60	55	1313
		▽										
		▽										
16.00		▽										
		▽										
		▽										
17.00		▽								62	62	
		▽										
		▽										
18.00		▽								66	66	
		▽										

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Dist. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 17/05/2011 To 22/05/2011

BORE HOLE NO.: BH-38

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 6.00m BGL

CO-ORDINATES: E-588100, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00													
2.00				1.50/ 2.10	SPT1	07	08	07	10	15			
3.00				3.00/ 6.00	SPT2	05	06	08	09	14			
4.00	100 mm		Brown silty Sand										
5.00				4.50/ 5.10	SPT3	08	10	15	25	25			
6.00				6.00/ 6.25	SPT4	20	51	--	--	R			
7.00				6.50									
8.00				8.00							25	NIL	
9.00				9.50							31	NIL	
10.00											33	NIL	

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 17/05/2011 To 22/05/2011

BORE HOLE NO.: BH-38

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 6.0m BGL

CO-ORDINATES: E-588100, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SGCM)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽		11.00	CORE					33	NIL	
12.00		▽		12.50	CORE					40	10	
13.00		▽		14.00	CORE					57	53	
14.00	NX	▽	Grey Basalt	15.50	CORE					60	55	1062
15.00		▽		17.00	CORE					65	58	1194
16.00		▽		18.00	CORE					70	60	626
17.00		▽										
18.00		▽										

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 23/05/2011 To 30/05/2011

BORE HOLE NO.: BH-39

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 4.50m BGL

CO-ORDINATES: E-588300, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SGCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Brown silty Sand	1.50/ 2.10	SPT1	06	06	08	10	3			
2.00													
3.00				2.00/ 3.00	SPT2	08	09	10	15	19			
4.00	NX		Grey Basalt	4.50/ 4.80	SPT3	30	51	--	--	R			
5.00				5.00									
6.00				6.50	CORE						20	NIL	
7.00	NX		Grey Basalt	8.00	CORE						25	NIL	
8.00				9.00	CORE						30	NIL	
9.00				10.00	CORE						40	NIL	
10.00													

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 23/05/2011 To 30/05/2011

BORE HOLE NO.: BH-39

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 4.50m BGL

CO-ORDINATES: E-588300, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽								45	NIL	
		▽		11.50								
12.00		▽								50	15	723
		▽		13.00								
13.00		▽										
	NX	▽		14.00						55	55	1261
14.00		▽	Grey Basalt	14.50								
15.00		▽								60	57	1064
16.00		▽		16.00								
		▽								63	53	
17.00		▽		17.00								
		▽								70	65	
18.00		▽		18.00								

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 31/05/2011 To 08/06/2011

BORE HOLE NO.: BH-40

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588700, N-2439600

DIAMETER : 100mm m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Completely weathered rock									
2.00				1.50/ 1.55	SPT1	51	--	--		R		
3.00				3.00								
4.00	NX		Grey Fractured Basalt	3.07 3.07	SPT2	55	--	--		R		
5.00				4.50						CORE	13	NIL
6.00				6.00						CORE	23	NIL
7.00				7.50						CORE	24	10
8.00				9.00						CORE	27	17
9.00			Grey Basalt							CORE	33	23
10.00										CORE	33	23

SPT N = STANDARD PENETRATION TEST VALUE

UCS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 31/05/2011 To 08/06/2011

BORE HOLE NO.: BH-40

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-588700, N-2439600

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG./SQCM)
				DEPTH (m)	TYPE	15	15				
		▽		10.50	CORE				33	23	
11.00		▽			CORE				37	21	
12.00		▽		12.00							
		▽			CORE				40	25	793
13.00		▽		13.00							
	NX	▽	Grey Basalt		CORE				54	50	
14.00		▽		14.50							
		▽			CORE				53	53	1327
15.00		▽		16.00							
		▽			CORE				60	60	
16.00		▽		17.00							
		▽			CORE				67	67	
17.00		▽		18.00							
		▽									
18.00		▽									

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 28/05/2011 to 06/06/2011

BORE HOLE NO.: BH-41

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589100, N-2439600

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG./SQCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Silty sand									
1.50												
2.00				1.50/ 1.55	SPT1	55	--	--	--			
3.00				3.00						17	NIL	
4.00				4.50						20	NIL	
5.00										27	19	
6.00				6.00								
7.00				7.50						33	11	911
8.00										33	18	
9.00				9.00						37	20	706
10.00												

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 28/05/2011 to 06/06/2011

BORE HOLE NO.: BH-41

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589100, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15			
				10.50	CORE				37	20	
11.00											
					CORE				42	20	
12.00				12.00							
					CORE				43	30	1383
13.00											
			Grey Basalt	13.50							
14.00	NX				CORE				58	53	
15.00				15.00							
					CORE				57	57	
16.00											
				16.50							
17.00					CORE				61	61	
18.00				18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 04/06/2011 To 10/06/2011

BORE HOLE NO.: BH-42

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589500, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE DEPTH (m)	TYPE	BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
1.00	100 mm		Silty Sand	1.00						
2.00				1.50/1.55	SPT1	50	--	--	R	
3.00			Grey completely weathered rock					09	NIL	
4.00				5.00/5.50	SPT2	50	--	--	R	
5.00				4.00				05	NIL	
6.00				5.00				11	NIL	
7.00				6.00				28	NIL	
8.00			Grey Fractured Basalt	7.50				30	NIL	
9.00				9.00				35	20	890
10.00								43	22	

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 04/06/2011 To 10/06/2011

BORE HOLE NO.: BH-42

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 2.50m BGL

CO-ORDINATES: E-589500, N-2439600

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
				10.50	CORE					43	22	
11.00												
					CORE					43	17	
12.00				12.00								
					CORE					46	33	267
13.00				13.50								
	NX		Grey fractured Basalt									
14.00					CORE					60	53	662
15.00				15.00								
					CORE					61	57	757
16.00				16.50								
					CORE					67	58	
17.00				18.00								
18.00												

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 20/06/2011 To 26/06/2011

BORE HOLE NO.: BH-43

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-585900, N-2441200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	100 mm		Silty sand mixed with boulders	1.50						10	NIL	
2.00										10	NIL	
3.00				3.00								
4.00	NX		Grey fractured Basalt	4.00					CORE	27	NIL	
5.00									CORE	30	NIL	
6.00				6.00								
7.00				7.50					CORE	40	22	959
8.00									CORE	43	27	
9.00				9.00								
10.00									CORE	39	29	1202

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Seida, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 20/06/2011 To 26/06/2011

BORE HOLE NO.: BH-43

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-585900, N-2441200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
		▽▽		10.50	CORE				39	29	
11.00		▽▽									
		▽▽			CORE				45	30	
12.00		▽▽		12.00							
		▽▽			CORE				45	33	
13.00		▽▽									
		▽▽		13.50							
14.00	NX	▽▽	Grey Basalt		CORE				60	55	830
15.00		▽▽		15.00							
		▽▽			CORE				57	57	
16.00		▽▽									
		▽▽		16.50							
17.00		▽▽			CORE				60	56	
18.00		▽▽		18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 09/07/2011 To 16/07/2011

BORE HOLE NO.: BH-44

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-585900, N-2440800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SCCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 mm		Silty sand mixed with boulders								10	NIL	
1.50													
2.00											30	NIL	
3.00				3.00									
4.00			Grey fractured Basalt								32	10	
4.50													
5.00	NX										33	10	
6.00				6.00									
7.00											40	25	
7.50			Grey Basalt										
8.00											42	24	
9.00				9.00									
											37	27	1108
10.00													

SPT N = STANDARD PENETRATION TEST VALUE

CR = CORE RECOVERY

UCS = UNDISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 09/07/2011 To 16/07/2011

BORE HOLE NO.: BH-44

METHOD : ROTARY DRILLING

LOCATION : --

CASING : Up to 3.00m BGL

CO-ORDINATES: E-585900, N-2440800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15				
				10.50	CORE					37	27	
11.00					CORE					40	23	
12.00				12.00								
					CORE					45	33	
13.00												
				13.00								
14.00					CORE					68	57	865
15.00				15.00								
					CORE					56	56	
16.00												
				16.50								
17.00					CORE					61	56	
18.00				18.00								

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 15/06/2011 To 22/06/2011

BORE HOLE NO.: BH-45

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.50m BGL

CO-ORDINATES: E-586700, N-2440800

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15					
1.00		+	Completely Weathered Rock								05	NIL	
2.00		+		1.50/ 1.75	SPT1	35	51	--		R			
3.00		+									10	NIL	
4.00		+		3.00/ 3.40	SPT2	55	--	--		R			
5.00		+	Reddish brown weathered Basalt rock	4.50/ 4.55	SPT3	51	--	--		R			
6.00		+		6.50							17	NIL	
7.00		+		7.50							30	NIL	
8.00		+									30	NIL	
9.00		+		9.00							37	17	208
10.00		+											

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 15/06/2011 To 22/06/2011

BORE HOLE NO.: BH-45

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.50m BGL

CO-ORDINATES: E-586700, N-2440800

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15				
				10.50	CORE					37	17	
11.00												
					CORE					40	24	
12.00				12.00								
					CORE					43	31	355
13.00				13.50								
					CORE					57	50	
14.00			Grey Basalt									
15.00				15.00								
					CORE					64	64	576
16.00				16.50								
					CORE					57	53	
17.00				18.00								
18.00												
19.00												
20.00												
21.00												
22.00												
23.00												
24.00												
25.00												
26.00												
27.00												
28.00												
29.00												
30.00												

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLECR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300**PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Dist. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 01/07/2011 To 14/07/2011

BORE HOLE NO.: BH-46

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.50m BGL

CO-ORDINATES: E-586700, N-2441400

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15				
0.00			Black cotton soil	0.50								
1.00												
2.00				1.50/ 1.60	SPT1	51	--	--	--	R		
3.00			Completely weathered rock									
4.00				3.50/ 3.60	PT2	55	--	--	--	R		
5.00				4.50/ 4.60	SPT3	55	--	--	--	R		
6.00				5.00								
7.00				6.50						30	13	
8.00												
9.00			Brown Basalt	8.00						35	18	
10.00												
				9.50						35	18	
										33	17	

SPT N =STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 01/07/2011 To 14/07/2011

BORE HOLE NO.: BH-46

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.50m BGL

CO-ORDINATES: E-586700, N-2441400

DIAMETER : 100mm & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE					BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG./SQCM)
				DEPTH (m)	TYPE	15	15	15				
11.00		▽		11.00	CORE					33	17	
12.00		▽		12.00	CORE					45	35	
13.00		▽		13.00	CORE					48	28	
14.00	NX	▽	Grey Basalt	14.00	CORE					56	50	
15.00		▽			CORE					60	60	
16.00		▽		16.00								
17.00		▽			CORE					61	61	
17.50				17.50								

BORE HOLE IS TERMINATED AT 17.50 M. BGL.

SPT N = STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 17.50 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 1 OF 2

DATE : 03/07/2011 to 12/07/2011

BORE HOLE NO: BH-47

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587100, N-2441200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ SQCM)
				DEPTH (m)	TYPE	15	15	15				
0.50	100 mm		Silty sand mixed with boulders	0.50								
1.00										05	NIL	
1.50				1.50								
2.00	NX									08	NIL	
2.50												
3.00				3.00								
3.50	NX									25	NIL	
4.00												
4.50				4.50								
5.00	NX		Grey fractured Basalt							27	10	532
5.50												
6.00				6.00								
6.50	NX									33	17	
7.00												
7.50				7.50								
8.00	NX									33	15	1258
8.50												
9.00				9.00								
9.50	NX									37	17	
10.00												

SPT N = STANDARD PENETRATION TEST VALUE

UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUED ON NEXT PAGE

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0300

CLIENT : NTPC LIMITED

PROJECT : Preliminary Geotechnical Investigation for main plant, and allied areas, for proposed Super Thermal Power Project (2 x 660 MW) near village Selda, Town Sanawad in Distt. Khargone, M.P.

SHEET NO. : 2 OF 2

DATE : 03/07/2011 to 12/07/2011

BORE HOLE NO.: BH-47

METHOD : ROTARY DRILLING

LOCATION : -

CASING : Up to 3.00m BGL

CO-ORDINATES: E-587100, N-2441200

DIAMETER : 100m m & NX

REDUCED LEVEL : --

GROUND W. T. : NMW

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG /SQCM)
				DEPTH (m)	TYPE	15	15	15			
		▽		10.50	CORE				37	17	
11.00		▽			CORE				39	25	
12.00		▽		12.00							
		▽			CORE				41	20	
13.00		▽									
		▽	Grey Basalt	13.50							
14.00		▽			CORE				55	50	1050
15.00	NX	▽		15.00							
		▽			CORE				61	53	
16.00		▽									
		▽		16.50							
17.00		▽			CORE				63	63	
18.00		▽		18.00							

BORE HOLE IS TERMINATED AT 18.00 M. BGL.

SPT N =STANDARD PENETRATION TEST VALUE
UDS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 18.00 M BELOW EXISTING GROUND LEVELS

SCALE : 1: 50
JOB NO. : 0300

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

CLAUSE NO.

TECHNICAL REQUIREMENTS



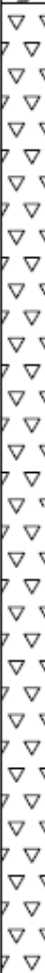
CLIENT ; NTPC													
PROJECT : SOIL INVESTIGATION FOR PROPOSE CONSTRUCTION OF INTAKE WELL FOR STPP KHARGONE AT THE SITE OF RESERVOIR OF OMKARESHWAR DAM													
SHEET NO. : 1 OF 1						DATE : 19/04/2012 TO 01/05/2012							
BORE HOLE NO: BHW-1						METHOD : ROTARY DRILLING							
GROUND R.L. : —						CASING : NX 5.50 M BBL							
GROUND W. T. : 10.50 M ABOVE BED LEVEL						DIAMETER : 100 MM AND NX							
LOCATION: INTAKE WELL													
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KS/52CM)
				DEPTH (m)	TYPE	15	15	15	15				
	100 MM		Sandy Silty Clay 0.50										
1.00	NX		Brownish coloured highly to moderately strong fractured Basalt		CORE					6	NIL		
2.00				2.00									
3.00					CORE					12	NIL		
4.00				3.00									
4.00					CORE					12	NIL		
4.00 / 4.10				4.00 / 4.10		SPT 1	50	-	-				-
5.00					CORE					14	NIL		
5.00				5.00									
6.00					CORE					21	NIL		
6.00				6.00									
7.00		CORE					19	NIL					
7.00	7.00												
8.00		CORE					23	NIL					
8.00	8.00												
9.00		CORE					42	20					
9.00	9.00												
BORE HOLE IS TERMINATED AT 9.0 M DEPTH BELOW BED LEVEL.													
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY													
UDS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION													
REMARKS : BORE HOLE IS TERMINATED AT 9.0 M DEPTH BELOW BED LEVEL.												SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.												JOB NO. : 0400	

KHARGONE STPP
(2X660MW)
EPC PACKAGE

TECHNICAL SPECIFICATION

SUB-SECTION-
CIVIL WORKS

PAGE
304 OF 393

CLIENT ; NTPC													
PROJECT : SOIL INVESTIGATION FOR PROPOSE CONSTRUCTION OF INTAKE WELL FOR STPP KHARGONE AT THE SITE OF RESERVOIR OF OMKARESHWAR DAM													
SHEET NO. : 1 OF 2						DATE : 07/05/2012 TO 30/05/2012							
BORE HOLE NO: BHW-2						METHOD : ROTARY DRILLING							
GROUND R.L. : —						CASING : 100 MM 3.0 M AND NX 5.50 M BBL							
GROUND W. T. : 6.0 M ABOVE BED LEVEL						DIAMETER : 100 MM AND NX							
LOCATION: INTAKE WELL													
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SCM)
				DEPTH (m)	TYPE	15	15	15	15				
	100 MM		Sandy Silty Clay 0,50										
1.00	NX		Brownish coloured Highly weathered Moderately fractured jointed highly strong Basalt	1.50		CORE					13	NIL	
2.00		1,50 / 1,53		SPT 1	50	-	-	-	R				
		2.50			CORE					13	NIL		
3.00		3.50			CORE					12	NIL		
4.00		3,50 / 3,55		SPT 2	50	-	-	-	R				
		4,50			CORE					18	NIL		
5.00		5,50			CORE					21	NIL		
6.00		5,50 / 5,57		SPT 3	50	-	-	-	R				
		6,50			CORE					19	NIL		
7.00		7,50			CORE					25	NIL		
8.00		7,50 / 7,55		SPT 4	50	-	-	-	R				
		8,50			CORE					33	NIL		
9.00		9,50			CORE					23	NIL		
10.00		9,50 / 9,55		SPT 5	50	-	-	-	R		39	NIL	
SPT N=STANDARD PENETRATION TEST VALUE K=INSITU PERMEABILITY CR= CORE RECOVERY UDS = UNDISTURBED SOIL SAMPLE DS=DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION													
REMARKS : BORE HOLE CONTINUES...												SCALE : 1: 50 JOB NO. : 0400	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.													

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT ; NTPC													
PROJECT : SOIL INVESTIGATION FOR PROPOSE CONSTRUCTION OF INTAKE WELL FOR STPP KHARGONE AT THE SITE OF RESERVOIR OF OMKARESHWAR DAM													
SHEET NO. : 2 OF 2					DATE : 07/05/2012 TO 30/05/2012								
BORE HOLE NO: BHW-2					METHOD : ROTARY DRILLING								
GROUND R.L. : —					CASING : 100 MM 3.0 M AND NX 5.50 M BBL								
GROUND W. T. : 6.0 M ABOVE BED LEVEL					DIAMETER : 100 MM AND NX								
LOCATION: INTAKE WELL													
DEPTH (m.)	DIA OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
11.00	NX	▽	Brownish coloured Fresh moderattely strong fine grained Basalt	10.50	CORE					39	NIL		
				CORE					30	NIL			
12.00				CORE					18	NIL			
				CORE					30	NIL			
13.00				CORE					50	NIL			
				CORE					55	NIL			
15.00				CORE									
16.00	BORE HOLE TERMINATED AT 15.5 M DEPTH BELOW BED LEVEL												
17.00													
18.00													
19.00													
20.00													
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY													
UDS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION													
REMARKS : BORE HOLE TERMINATED AT 15.5 M DEPTH BELOW BED LEVEL										SCALE : 1: 50			
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400			

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC												
PROJECT : SOIL INVESTIGATION FOR PROPOSE CONSTRUCTION OF INTAKE WELL FOR STPP KHARGONE AT THE SITE OF RESERVOIR OF OMKARESHWAR DAM												
SHEET NO. : 1 OF 2					DATE : 03/06/2012 TO 06/06/2012							
BORE HOLE NO: BHW-3					METHOD : ROTARY DRILLING							
GROUND R.L. : —					CASING : 100 MM 4.5 M AND NX 6.0 M BBL							
GROUND W. T. : 2.20 M ABL					DIAMETER : 100 MM AND NX							
LOCATION: INTAKE WELL												
DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/SCCM)
				DEPTH (m)	TYPE	15	15					
	100 MM		Sandy Silty Clay 0,50									
1,00		+	Brownish coloured highly weathered, highly fractured jointed, highly strong Basalt which is fresh and fine grained							12	NIL	
2,00		+								29	10	
3,00		+								26	NIL	
4,00		+								23	NIL	
5,00		+								22	NIL	
6,00		+								30	NIL	
7,00		+								30	NIL	
8,00		+								37	12	
9,00		+								25	NIL	
10,00		+										
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UDS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION												
REMARKS : BORE HOLE CONTINUES...											SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.											JOB NO. : 0400	

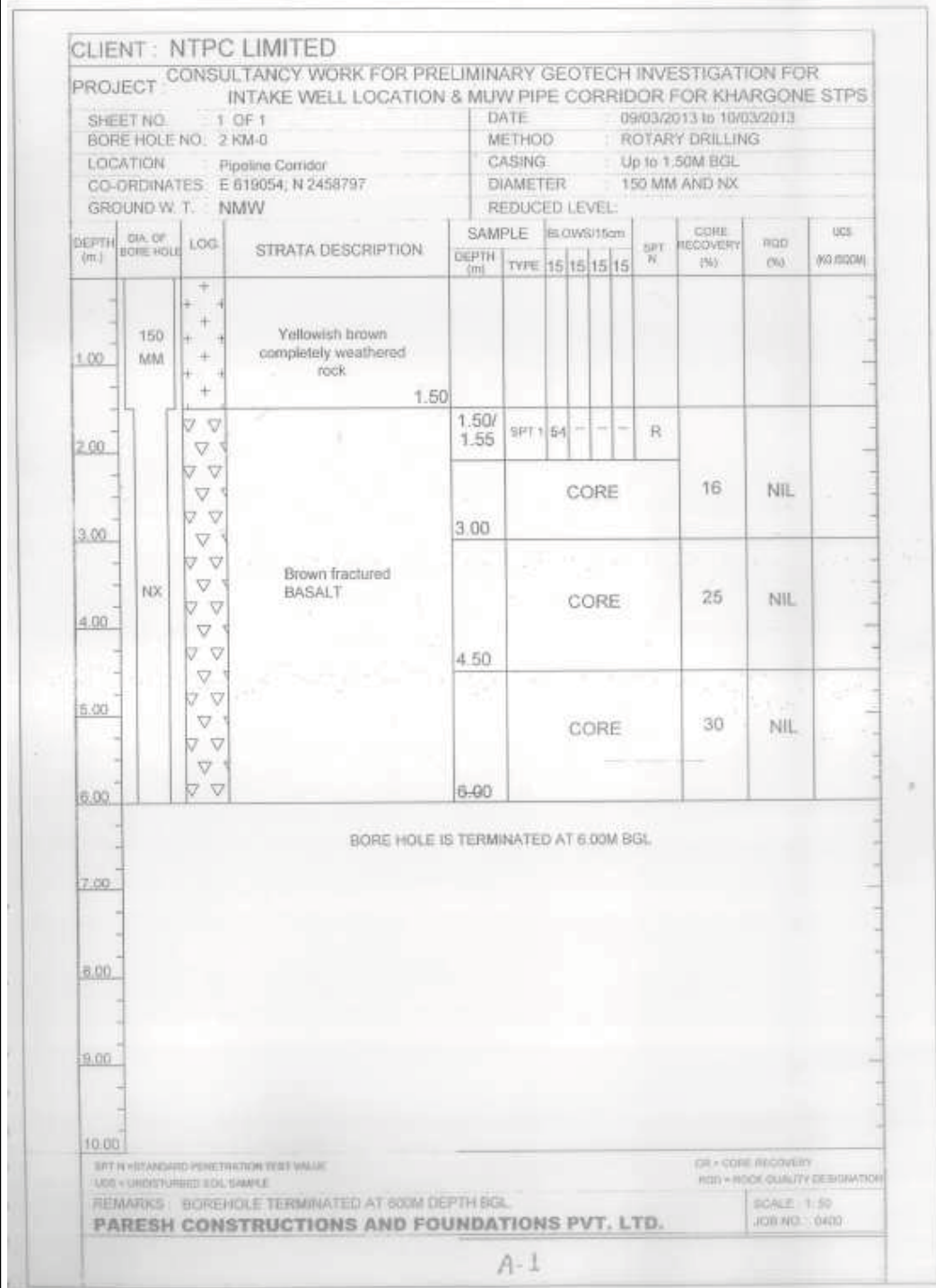
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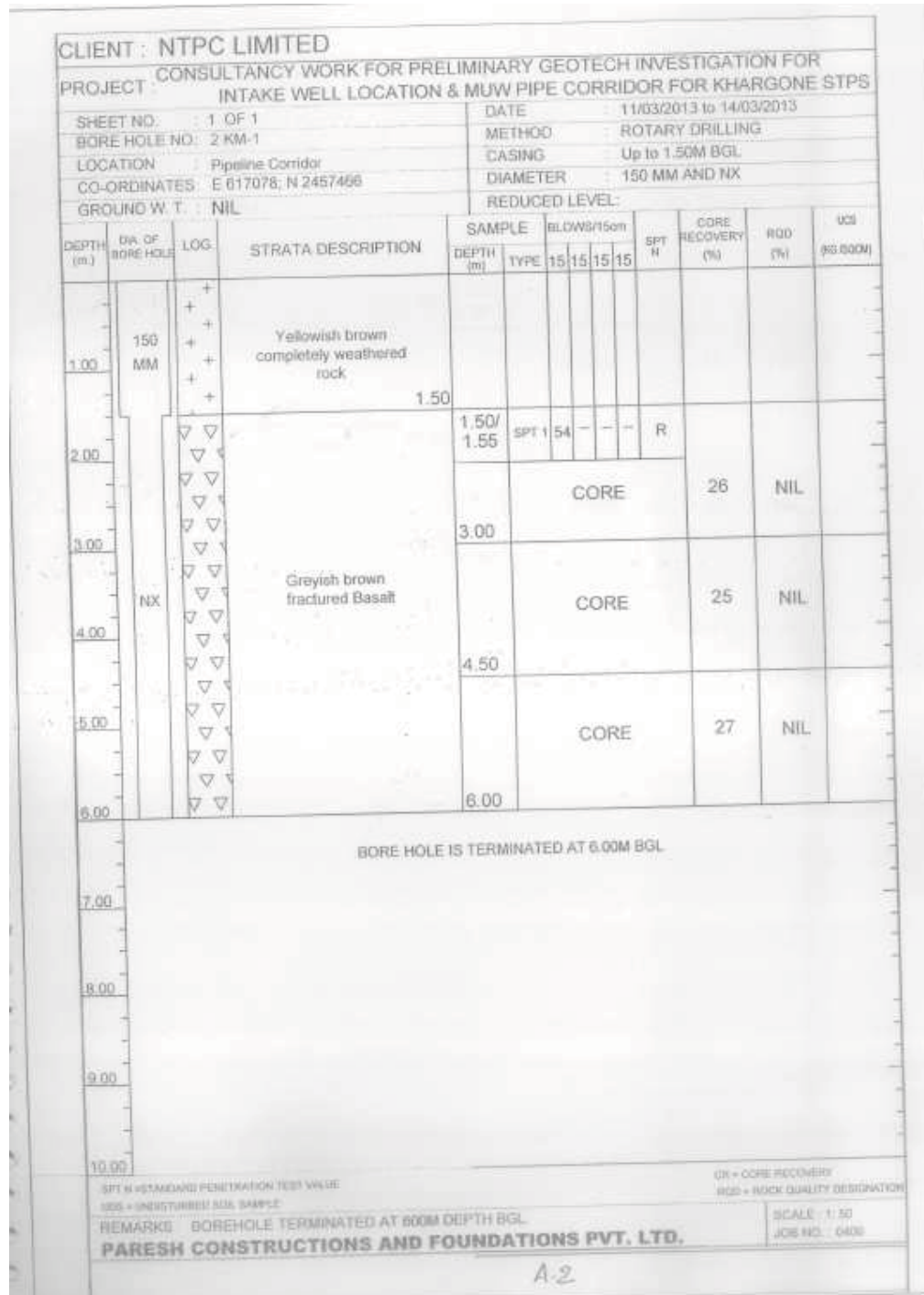
TECHNICAL REQUIREMENTS

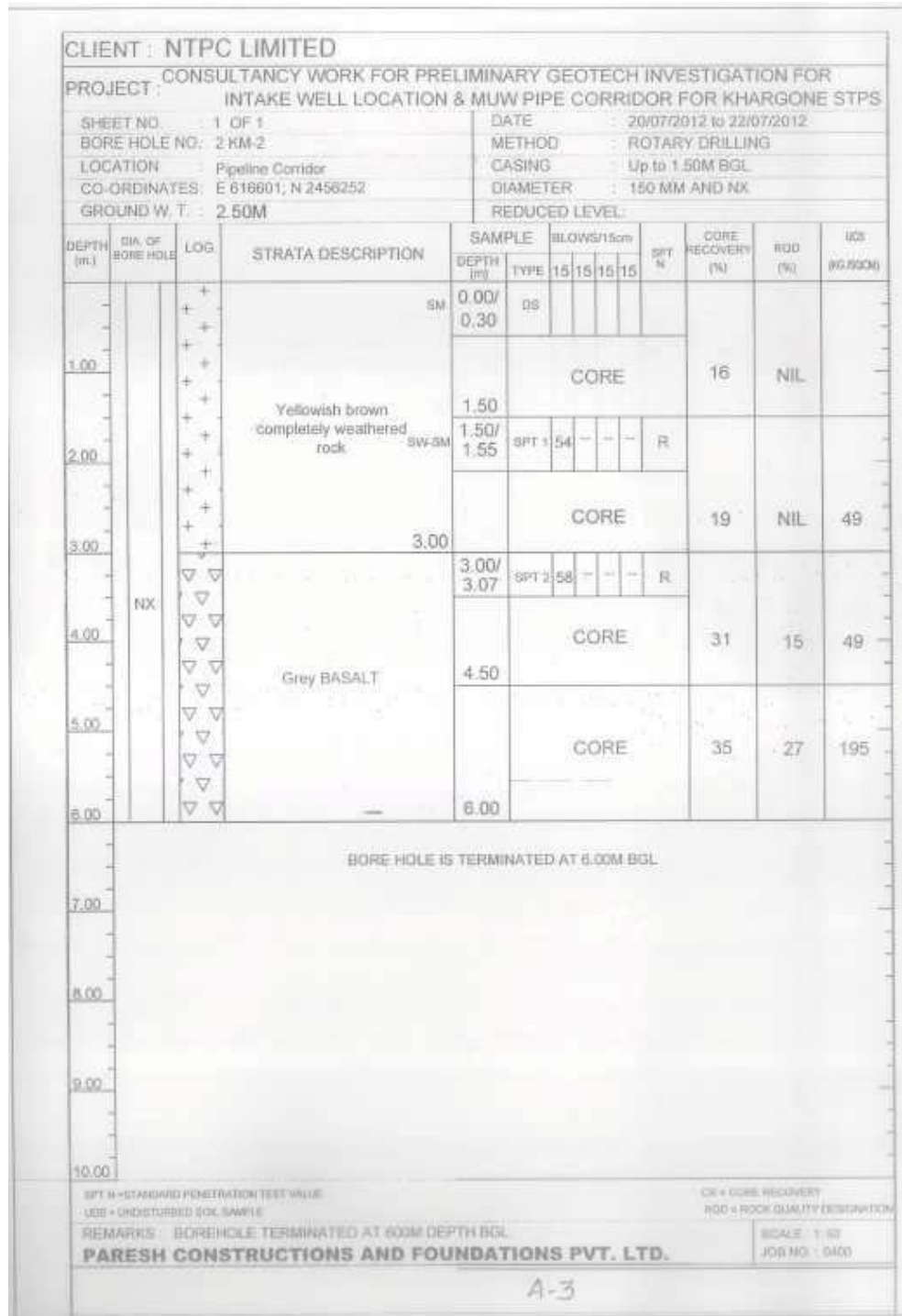


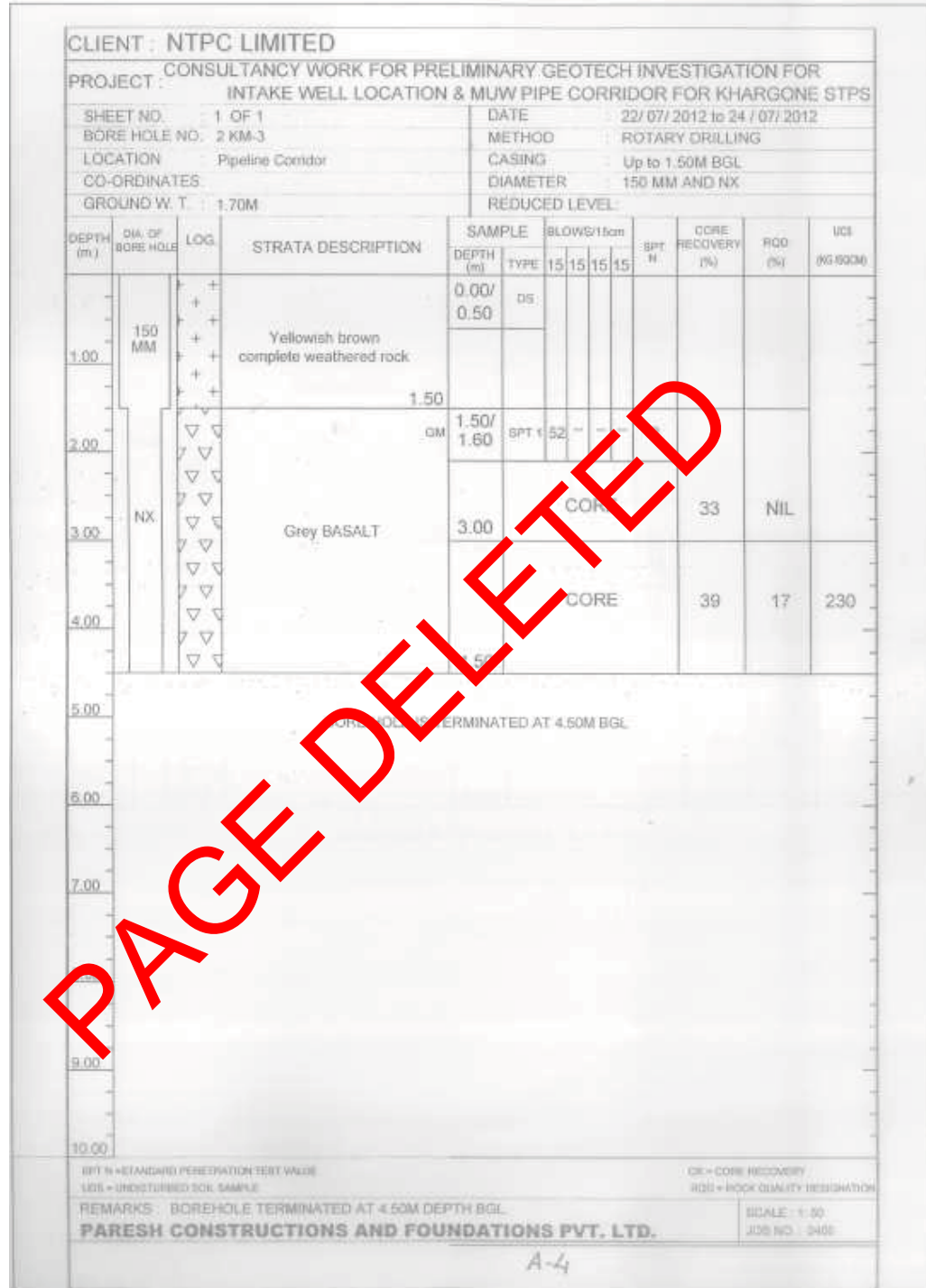
CLIENT : NTPC											
PROJECT : SOIL INVESTIGATION FOR PROPOSE CONSTRUCTION OF INTAKE WELL FOR STPP KHARGONE AT THE SITE OF RESERVOIR OF OMKARESHWAR DAM											
SHEET NO. : 2 OF 2					DATE : 03/06/2012 TO 06/06/2012						
BORE HOLE NO: BHW-3					METHOD : ROTARY DRILLING						
GROUND R.L. : —					CASING : 100 MM 4.5 M AND NX 6.0 M BBL						
GROUND W. T. : 2.20 M ABL					DIAMETER : 100 MM AND NX						
LOCATION: INTAKE WELL											
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm		SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15				
11.00	NX	▽	Moderately strong Brownish Basalt	11.00	CORE				32	NIL	
12.00		12.00		CORE				30	NIL		
13.00		13.00		CORE				19	NIL		
14.00		14.00		CORE				48	12		
15.00		15.00		CORE				63	24		
16.00		16.00		CORE				55	41		
17.00		17.00		CORE				54	54		
18.00		18.00		CORE				60	51		
19.00											
20.00											
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UCS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION											
REMARKS : BORE HOLE TERMINATED AT 18.0 M DEPTH BELOW BED LEVEL											
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.											
SCALE : 1: 50 JOB NO. : 0400											

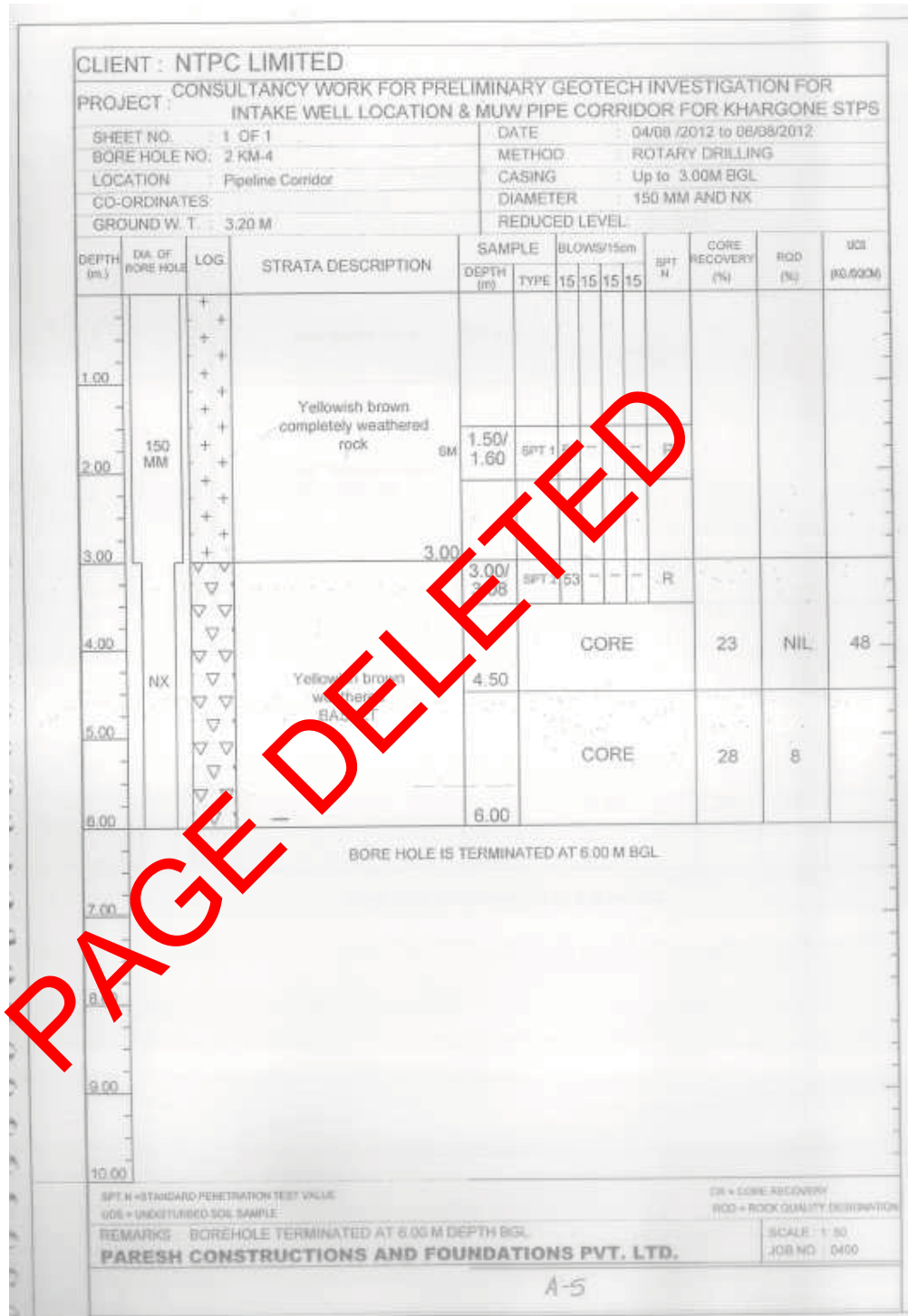
Bore hole data pipe line corridor

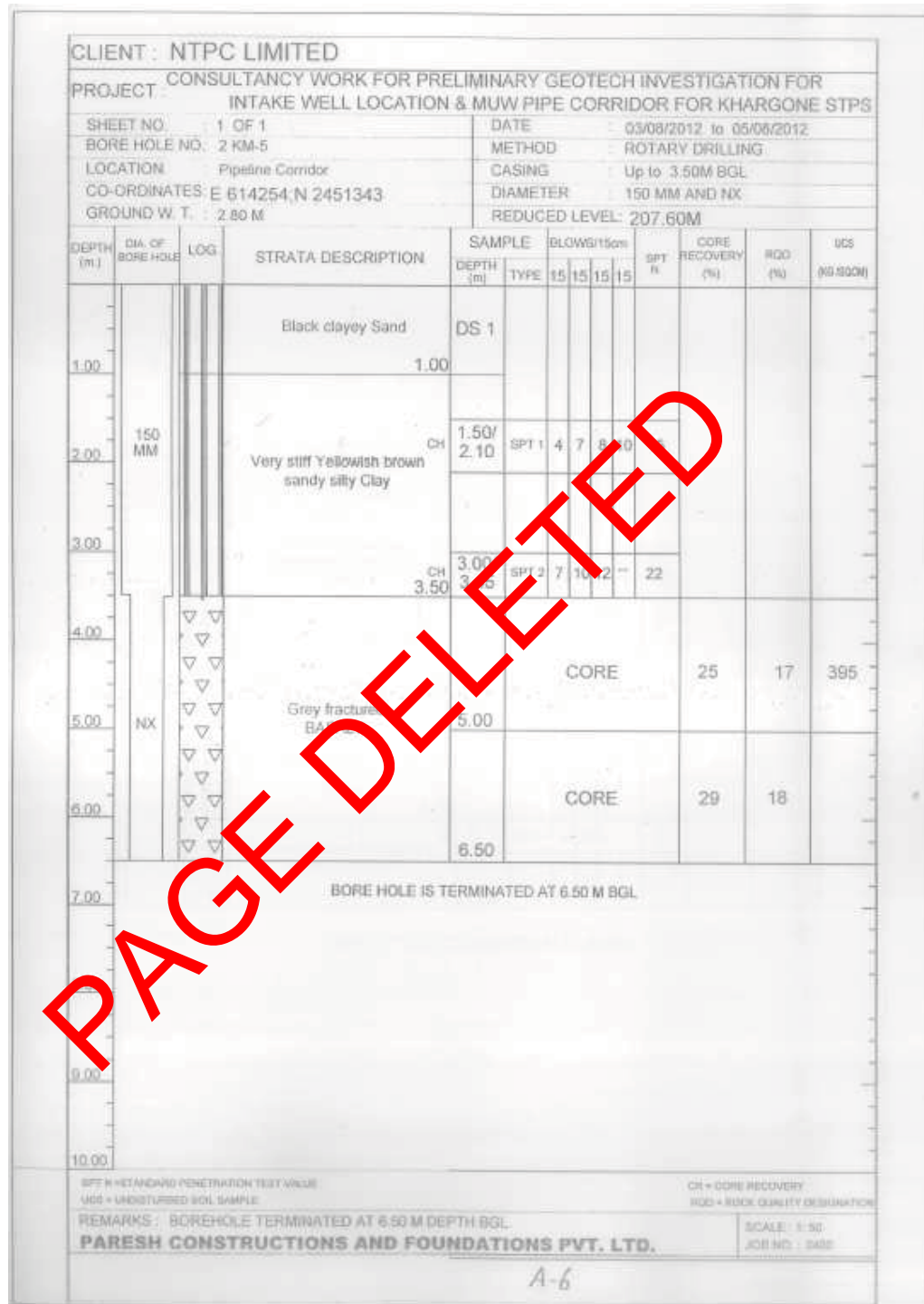


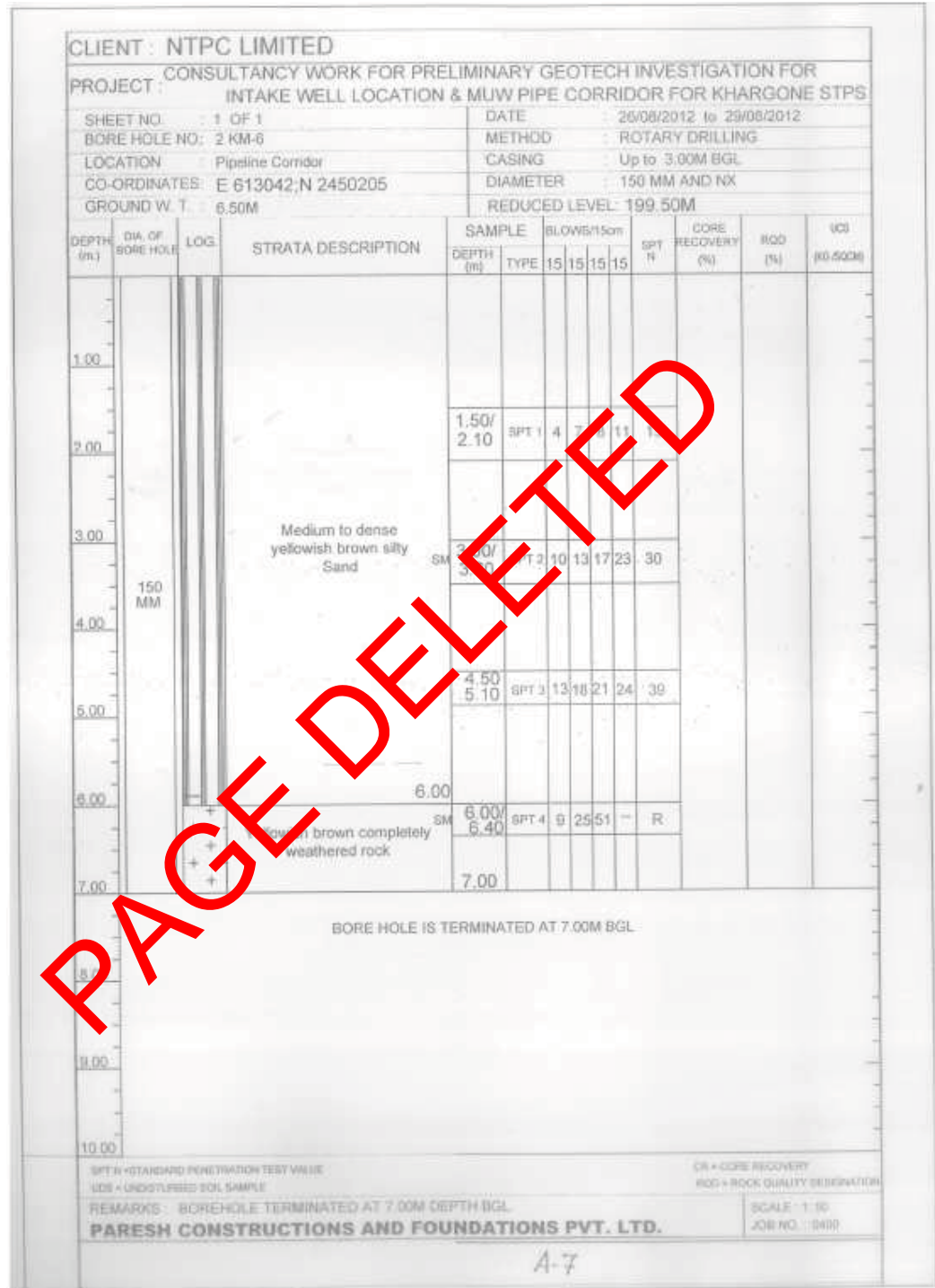


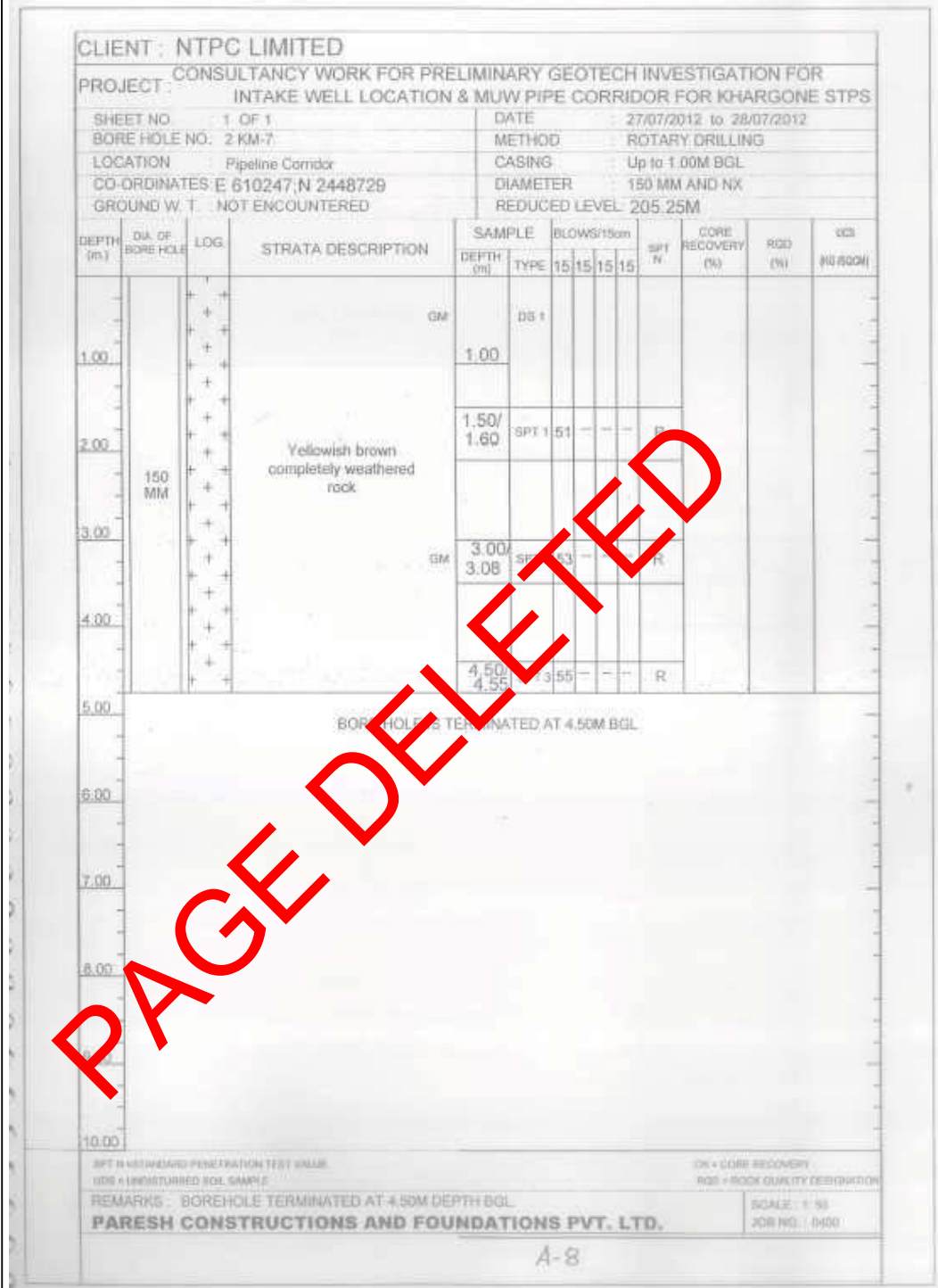


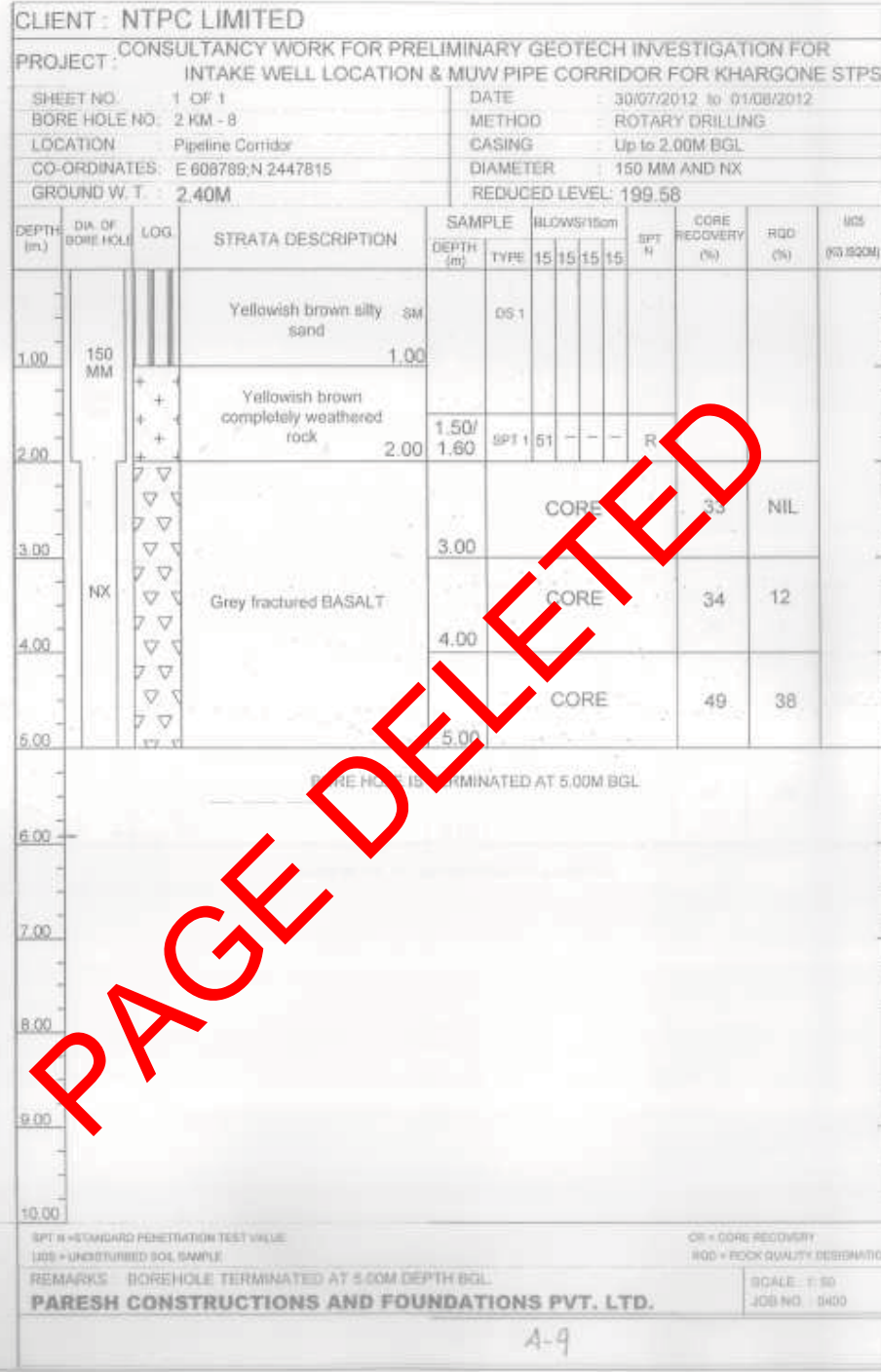


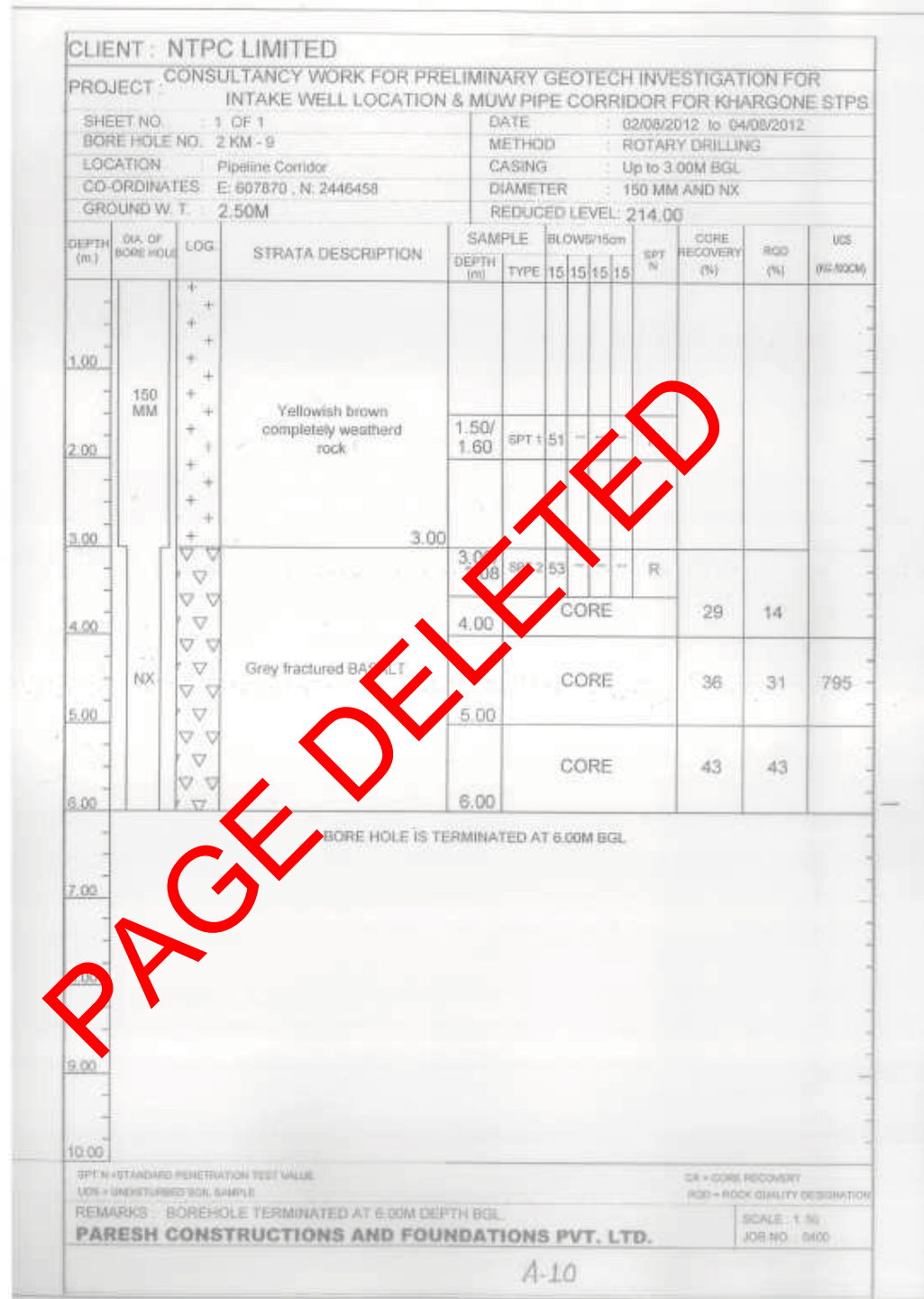


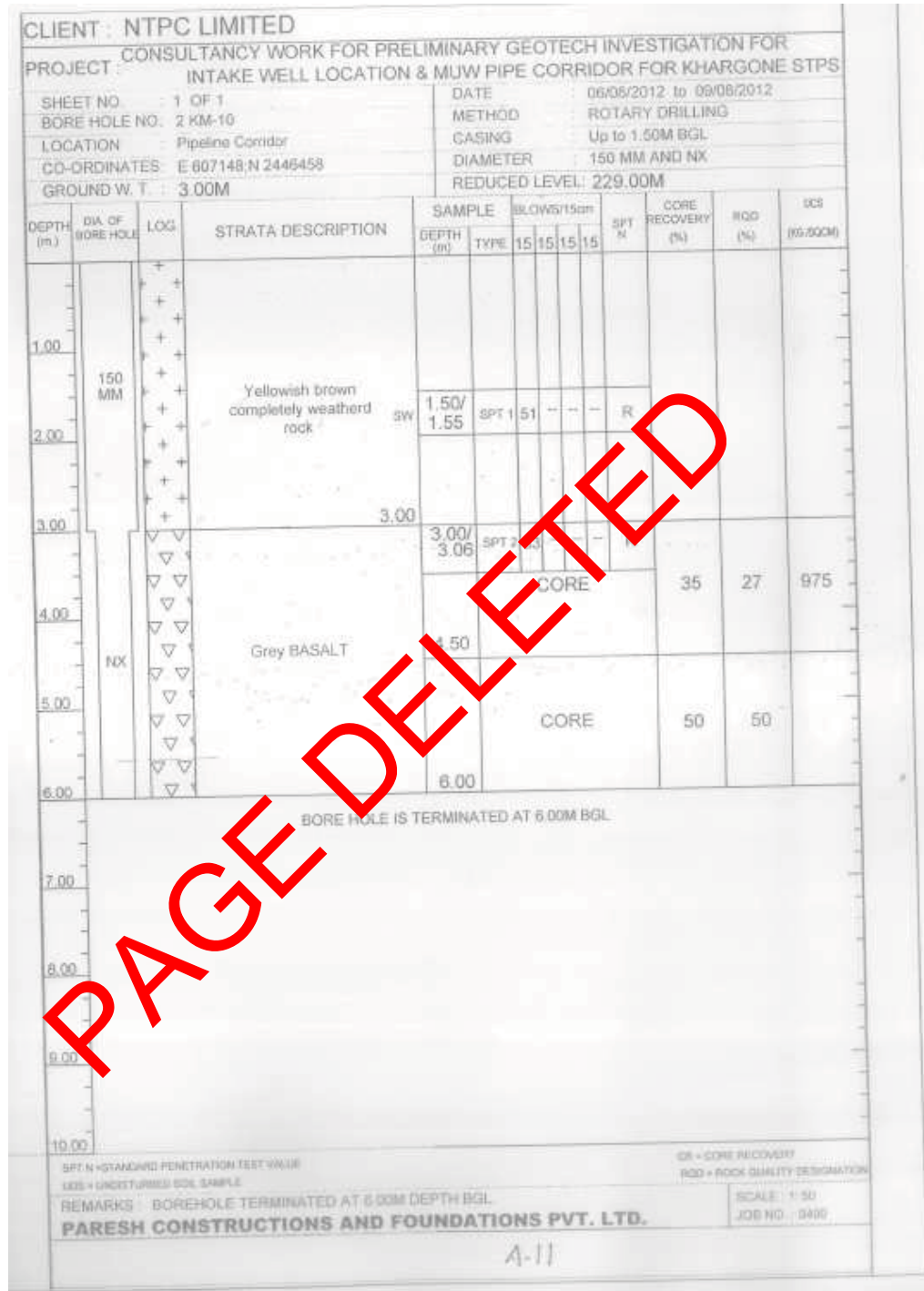


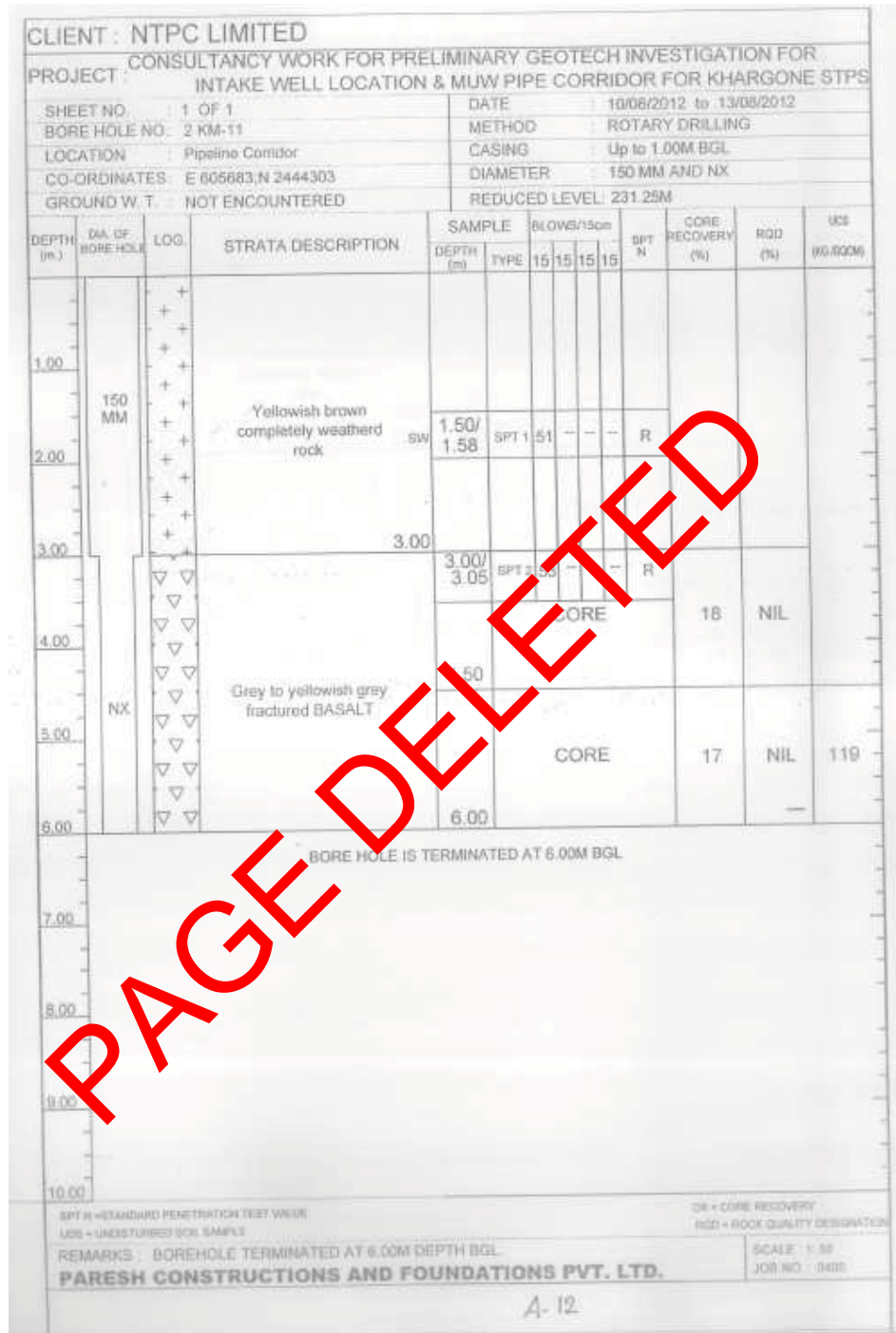


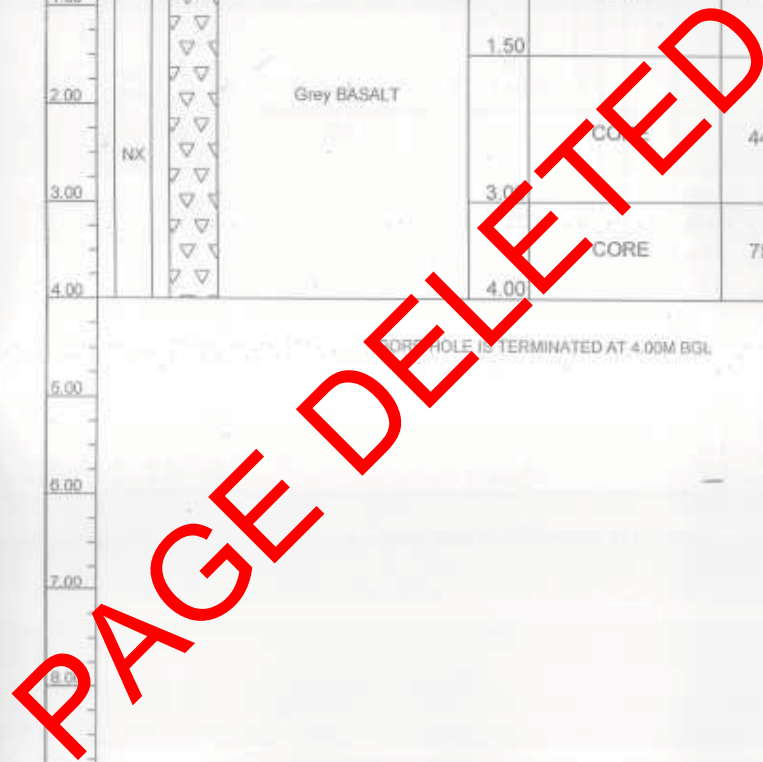


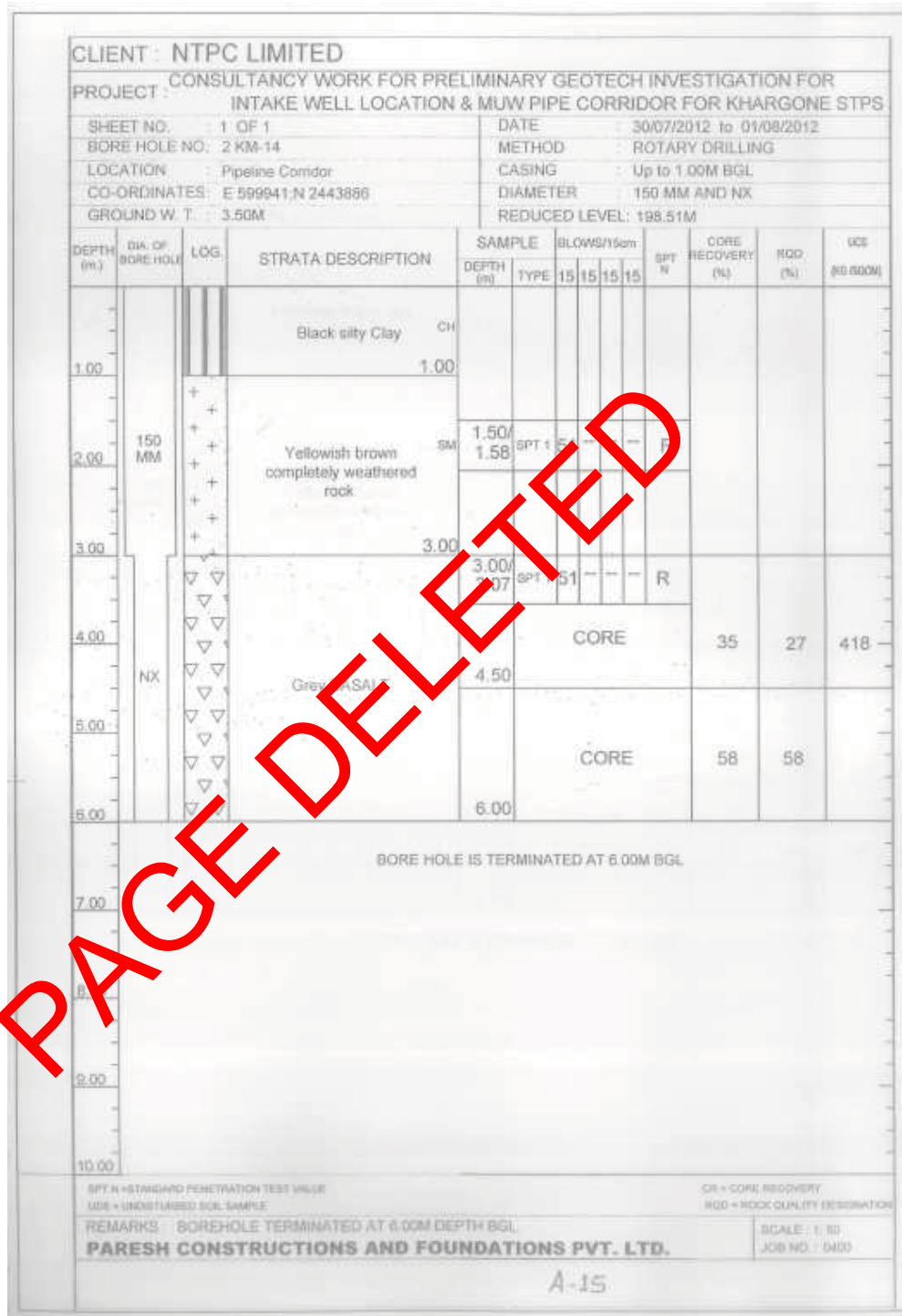


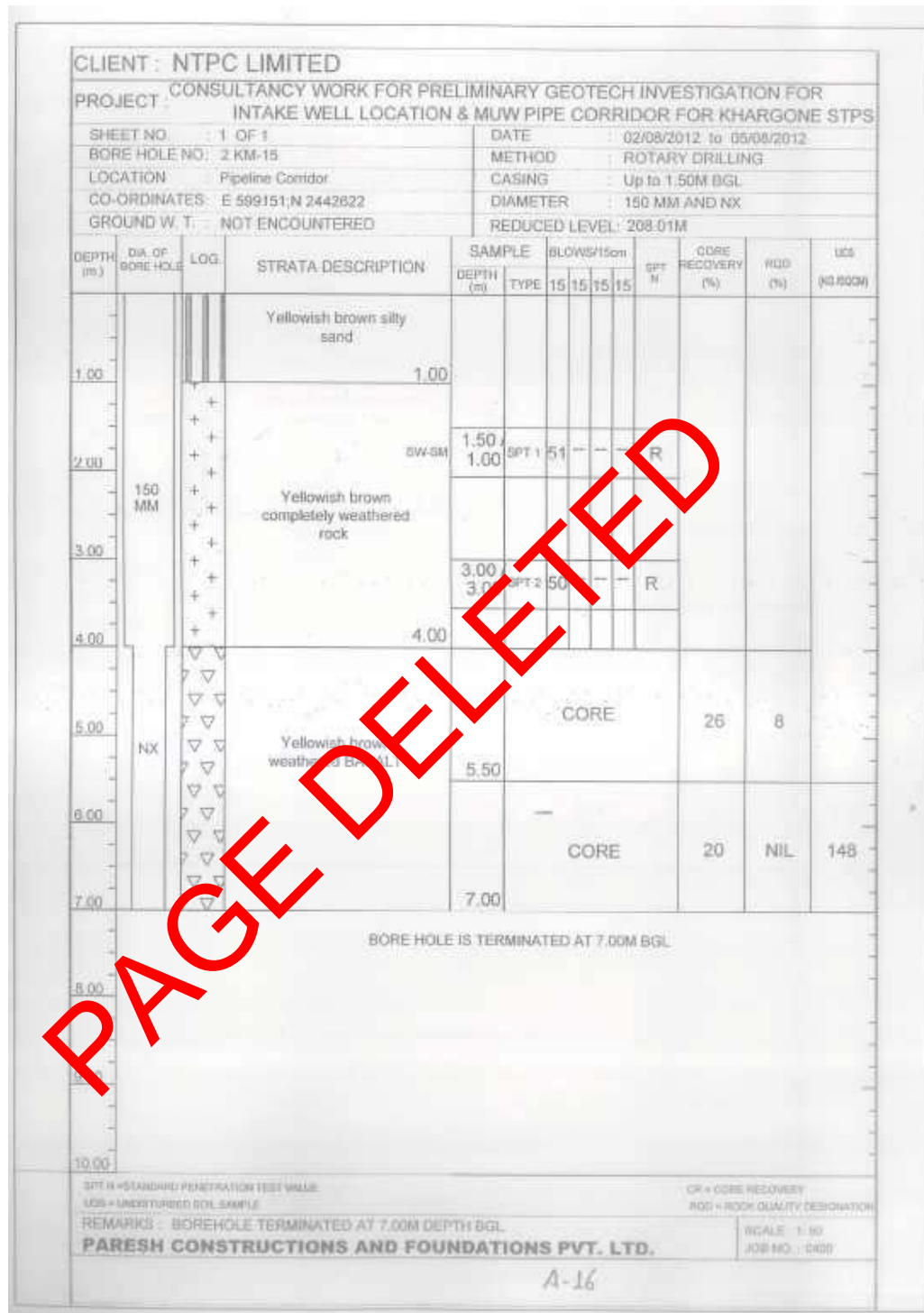


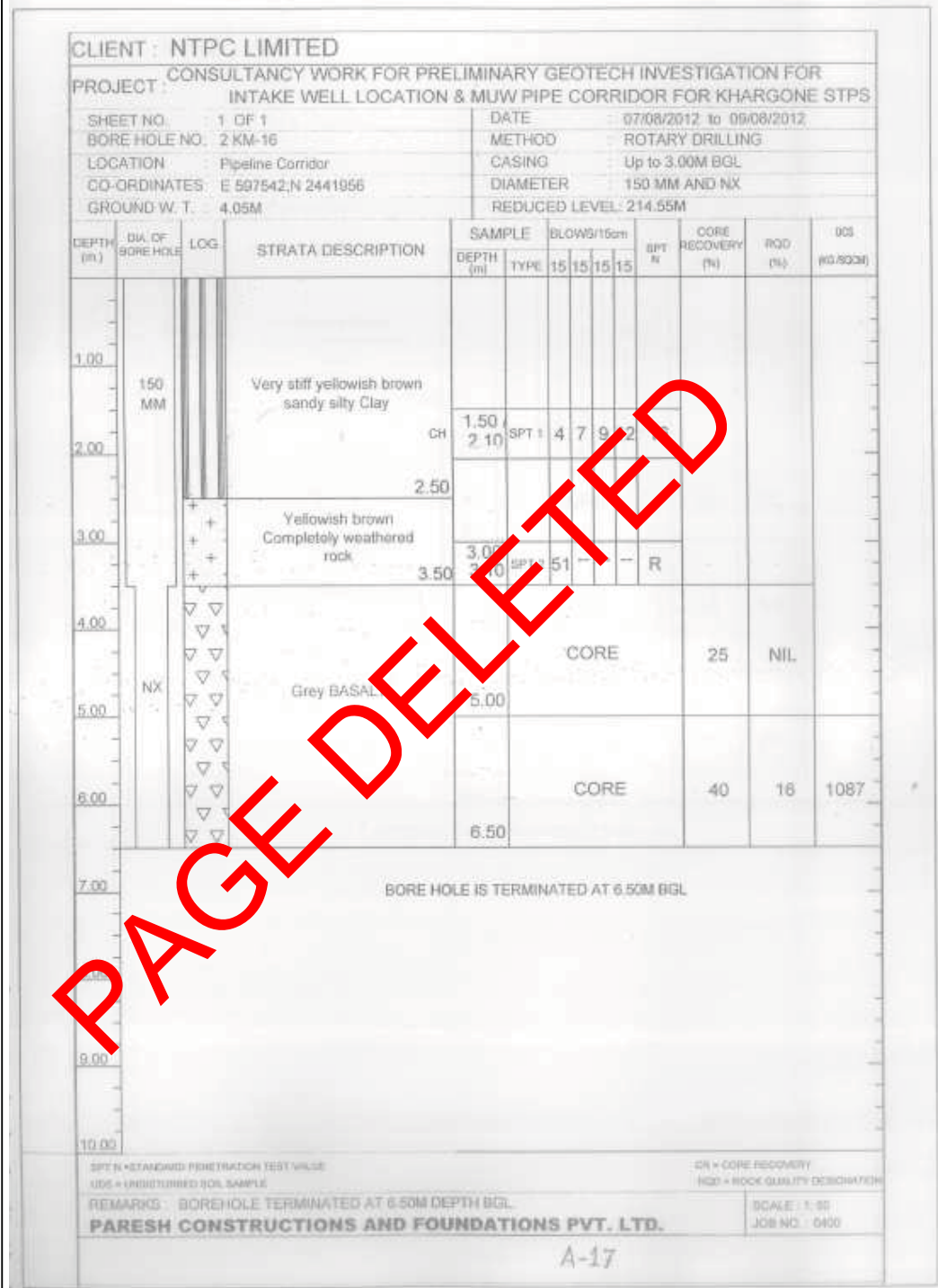


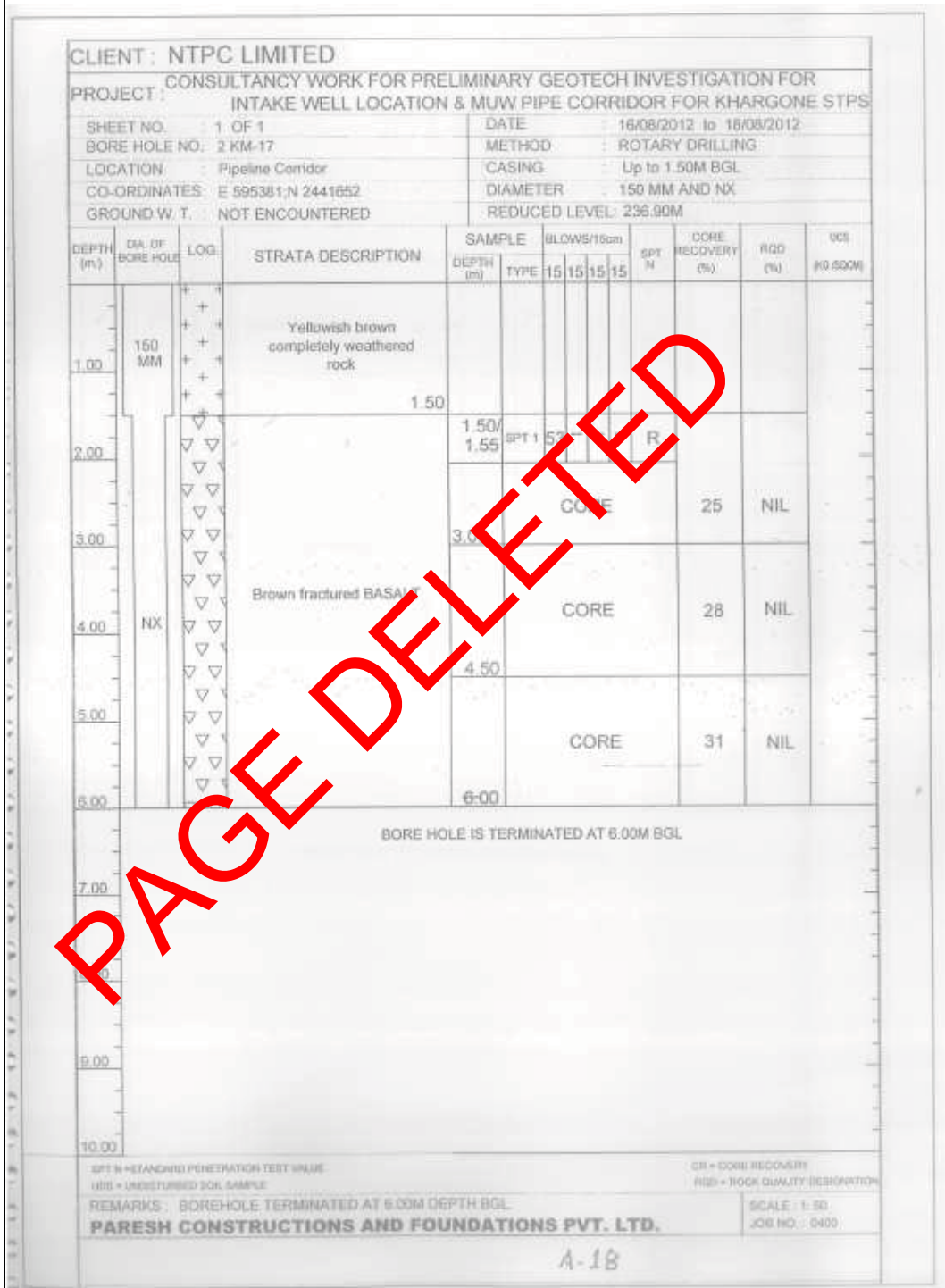


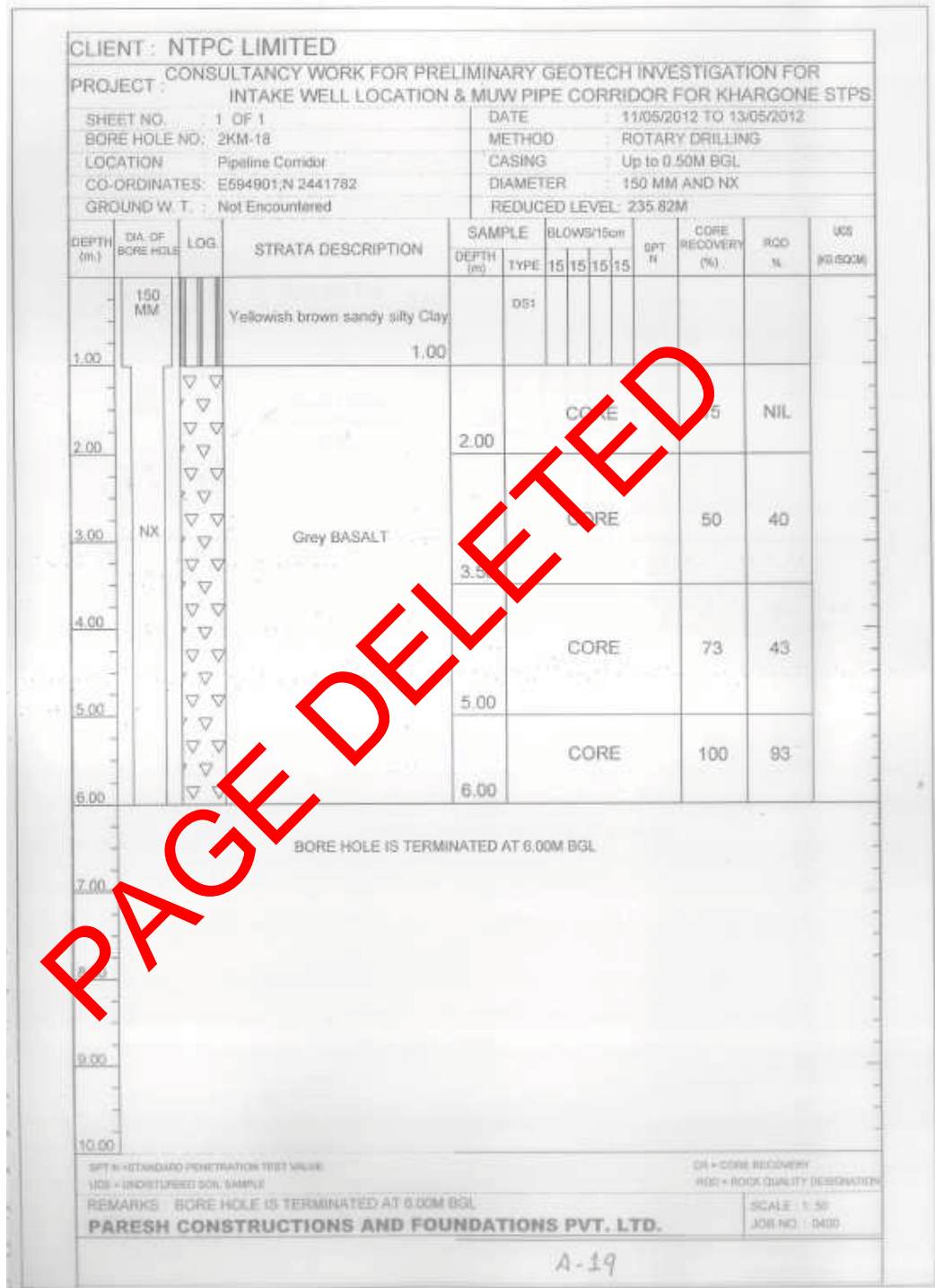


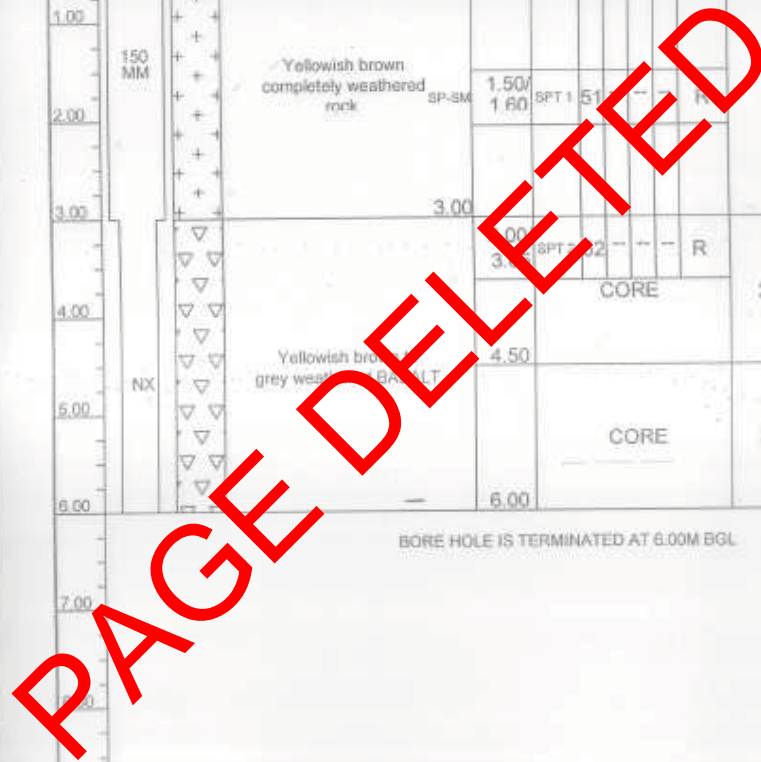


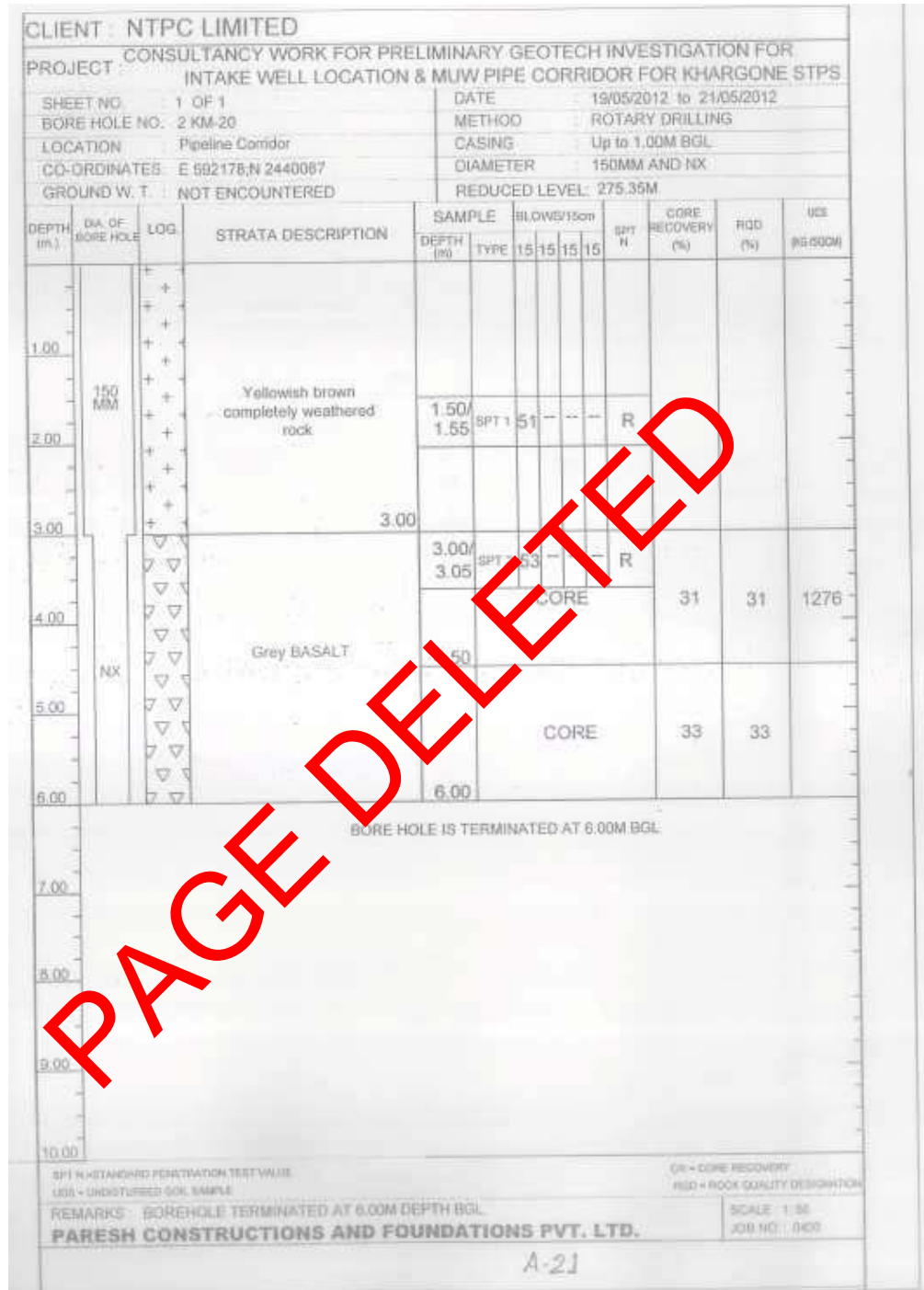










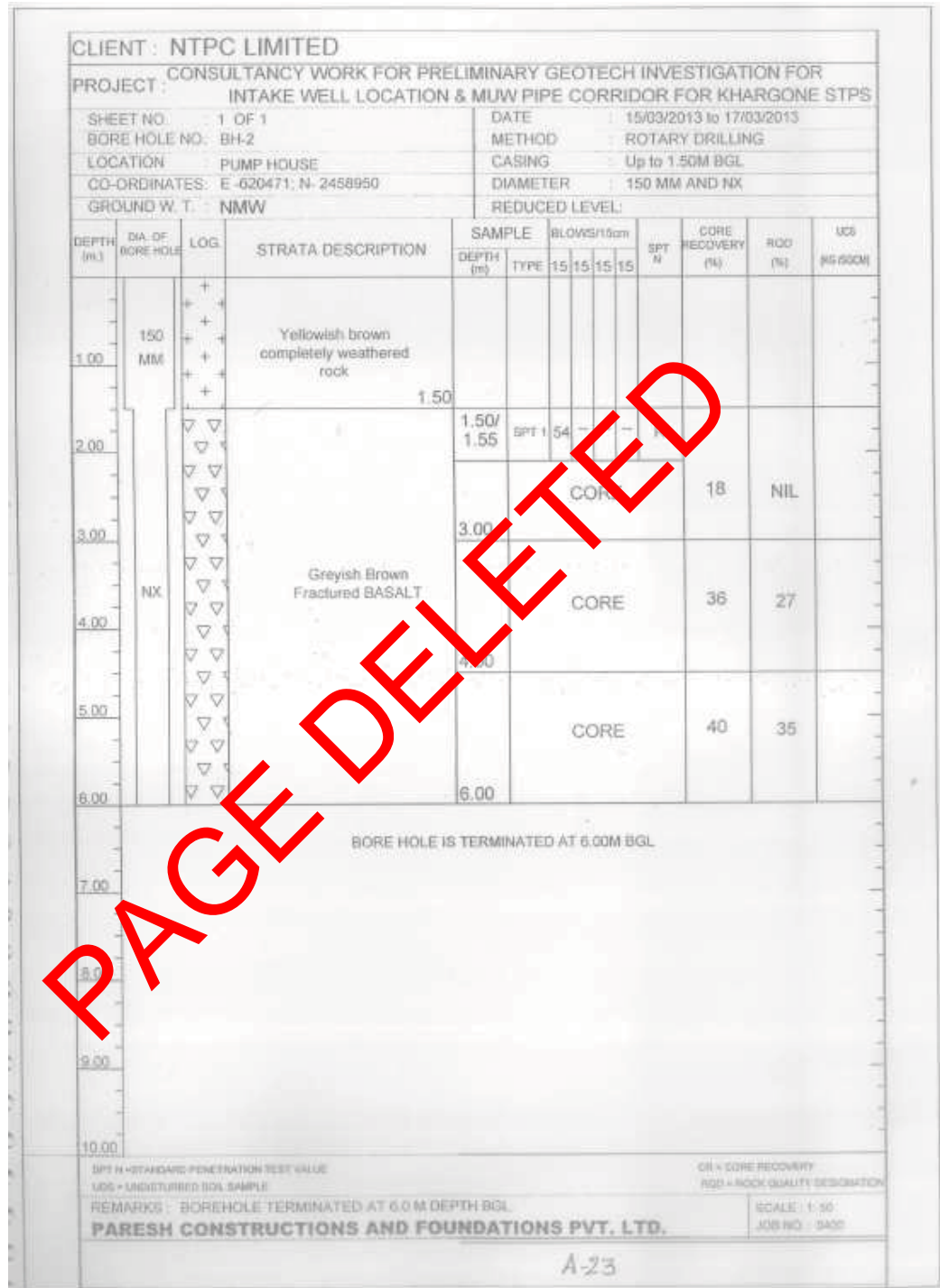


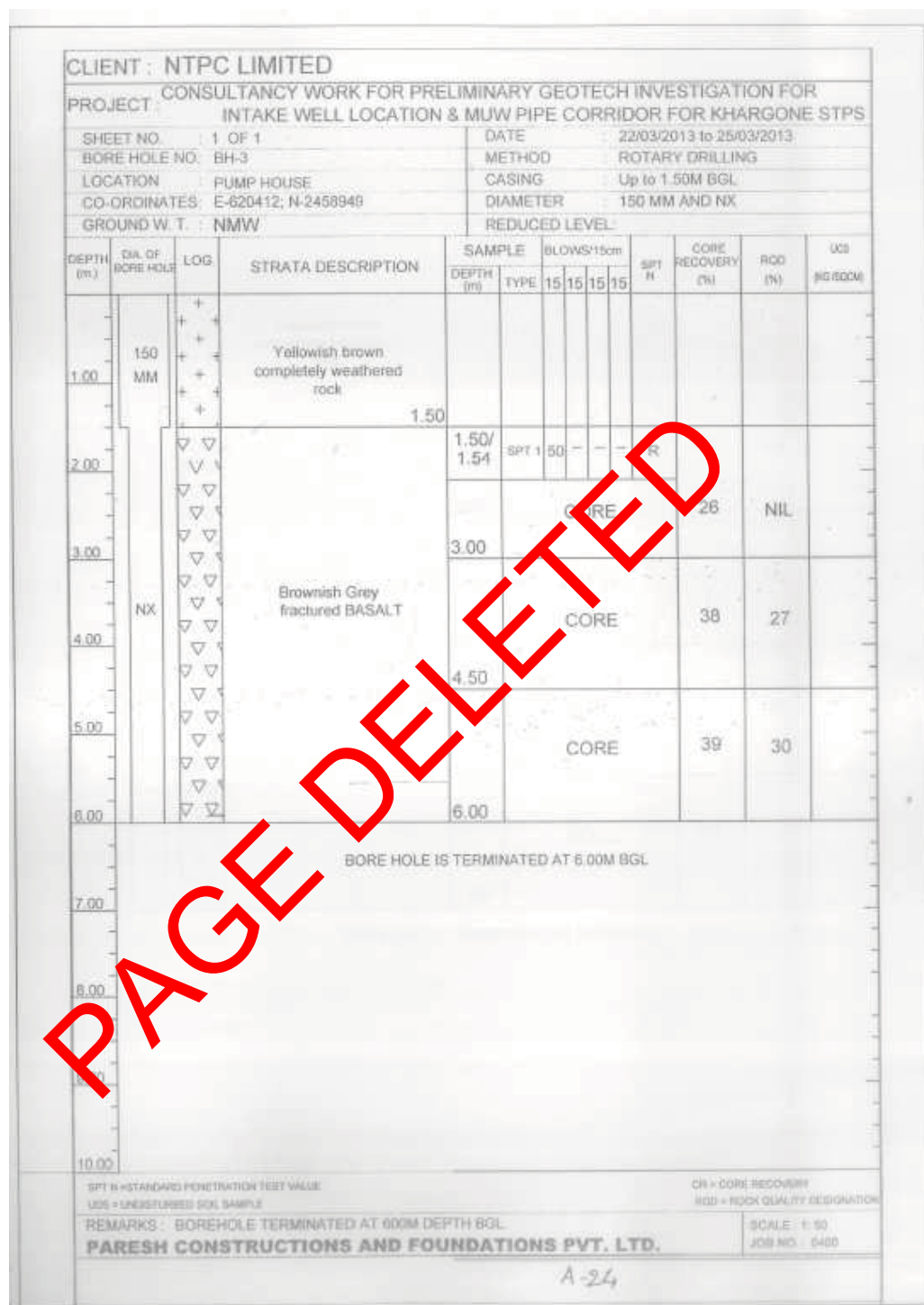
CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR
INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 1 OF 1	DATE : 04/08/2012 to 05/08/2012
BORE HOLE NO: 2 KM-21	METHOD : ROTARY DRILLING
LOCATION : Pipeline Corridor	CASING : Up to 1.50M BGL
CO-ORDINATES: E 589905;N 2439549	DIAMETER : 150 MM AND NX
GROUND W. T. : NOT ENCOUNTERED	REDUCED LEVEL: 275.35M

DEPTH (m.)	BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD (%)	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM	+	Yellowish brown completely weathered rock										
1.50		+											
2.00		▽		1.50	SPT 1	52	--	--	--	R			
3.00		▽									17	NIL	
4.00	NX	▽	Grey fractured BASALT								28	8	82
5.00		▽		4.50									
6.00		▽									33	19	951
7.00			BORE HOLE IS TERMINATED AT 6.00M BGL										
8.00													
9.00													
10.00													
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION REMARKS : BOREHOLE TERMINATED AT 6.00M DEPTH BGL. PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD. SCALE : 1 : 30 JOB NO. : 3403 4-22													





CLAUSE NO.

TECHNICAL REQUIREMENTS



Bore hole data river area

CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 2						DATE : 14/07/2012 TO 16/07/2012					
BORE HOLE NO: BH-1 Bank of Sala Nallah						METHOD : ROTARY DRILLING					
LOCATION : SALA NAHHAH						CASING : Up to 7.50 m BGL					
CO-ORDINATES : E 609671; N 2448224						DIAMETER : 150 MM AND NX					
GROUND W. T. : 3.00 M						REDUCED LEVEL: 197.95M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM2)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM		SM Medium dense brown silty Sand	1.00	DS1								
1.50/2.10				SPT 1	04	07	08	11	15				
3.00/3.60				SPT 2	05	08	12	14	20				
4.50/5.10				SPT 3	05	09	11	14	20				
6.00/6.60				SPT 4	09	11	13	15	24				
7.50													
8.00													
9.00													
9.00													
10.00													
			Grey, BASALT		CORE					25	NIL		
					CORE					56	56	1527	

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1:50
 JOB NO. : 0400

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 2 OF 2					DATE : 14/07/2012 TO 16/07/2012						
BORE HOLE NO: BH-1 Bank of Sala Nallah					METHOD : ROTARY DRILLING						
LOCATION : SALA NALLAH					CASING : Up to 7.50 m BGL						
CO-ORDINATES: E 609871;N 2448224					DIAMETER : 150 MM AND NX						
GROUND W. T. : 3.00M					REDUCED LEVEL: 197.95M						
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm		SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15				
11.00	NX	▽▽▽▽▽▽▽▽▽▽	Grey to brown BASALT	10.50	CORE				56	56	
12.00				12.00	CORE				57	54	
BORE HOLE IS TERMINATED AT 12.00M BGL											
13.00											
14.00											
15.00											
16.00											
17.00											
18.00											
19.00											
20.00											
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UCS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION											
REMARKS : BORE HOLE IS TERMINATED AT 12.00M BGL										SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400	

CLIENT : NTPC LIMITED													
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR													
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 1 OF 1						DATE : 18/07/2012 To 22/07/2012							
BORE HOLE NO: BH-2 Mid way of Sala Nailha						METHOD : ROTARY DRILLING							
LOCATION : SALA NALLHA						CASING : Up to 5.00 m BGL							
CO-ORDINATES : E 609687;N 2448234						DIAMETER : 150 MM AND NX							
GROUND W. T. : 2.2 M BGL						REDUCED LEVEL: BL 197.25M							
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)	
				DEPTH (m)	TYPE	15	15	15					15
1.00	150 MM		Brown silty Sand mixed with gravels		DS1								
2.00				SM	1.50/ 2.10	SPT 1	04	05	07	07	12		
3.00				SM	3.00 3.60	SPT 2	04	06	08	09	14		
4.00					4.50 4.95	SPT 3	15	15	15	15	27		
5.00			5.00										
6.00	NX		Grey BASALT			CORE				26	07	1079	
7.00					CORE				51	51	1160		
8.00					CORE				59	59			
9.00					CORE								
10.00			9.50										
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION													
REMARKS : BORE HOLE IS TERMINATED AT 9.50M BGL										SCALE : 1: 50		JOB NO. : 0400	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.													

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 2						DATE : 01/08/2012 TO 05/08/2012					
BORE HOLE NO.: BH-1 Bank of Baswa River						METHOD : ROTARY DRILLING					
LOCATION : BASWA RIVER						CASING : Up to 9.00 m BGL					
CO-ORDINATES : E 612486;N 2449755						DIAMETER : 150 MM AND NX					
GROUND W. T. : 2.50 M						REDUCED LEVEL: 198.45M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (NO BQCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM				DS1								
2.00				1.50/2.10	SPT 1	04	05	07	00	12			
3.00				3.00/3.60	SPT 2	04	06	08	09	14			
4.00				4.50/5.10	SPT 3	09	12	14	19	26			
5.00				5.50/6.10	SPT 4	08	15	13	19	28			
6.00				6.50/7.10	SPT 5	09	14	17	21	31			
7.00				7.50/8.10	SPT 6	10	15	19	22	34			
8.00				8.50/9.10									
9.00				9.50/10.10									
10.00													

150 MM

Medium dense brown silty Sand

SW-SM

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE
CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1:50
JOB NO. : 0400

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR
INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 2 OF 2	DATE : 01/06/2012 TO 05/06/2012
BORE HOLE NO: BH-1 Bank of Baswa River	METHOD : ROTARY DRILLING
LOCATION : BASWA RIVER	CASING : Up to 8.00 m BGL
CO-ORDINATES: E 812486; N 2449756	DIAMETER : 150 MM AND NX
GROUND W. T. : 2.50 M	REDUCED LEVEL: 198.45 M

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15	15	15	15				
11.00	150 MM		Dense brown Silty Sand	10.50 11.10	SPT 7	09	14	19	22			33			
12.00				12.00 12.60	SPT 8	10	15	19	22			34			
13.00				13.50 14.10	SPT 9	18	21	14	11			50			
14.00				15.00 15.60	SPT 10	21	29	30	40			59			
15.00				16.50 17.10	SPT 11	18	17	23	40			40			
16.00				18.00 18.60	SPT 12	13	21	26	30			47			
17.00				19.50 20.10	SPT 13	13	19	24	31			43			
18.00															
19.00															
20.00															

SPT N = STANDARD PENETRATION TEST VALUE

K = INSITU PERMEABILITY

CR = CORE RECOVERY

UCS = UNDISTURBED SOIL SAMPLE

DS = DISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 20.10 M BGL

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1 : 50

JOB NO. : 0400

CLIENT : NTPC LIMITED										
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS										
SHEET NO. : 1 OF 2					DATE : 24/06/2012 TO 29/06/2012					
BORE HOLE NO: BH-2 MIDWAY OF BASWA RIVER					METHOD : ROTARY DRILLING					
LOCATION : BASWA RIVER					CASING : Up to 8.00M BGL					
CO-ORDINATES: E 612512;N 2449721					DIAMETER : 150 MM AND NX					
GROUND W. T. : 0.0 M					REDUCED LEVEL: 191.25 M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KD (SQCM))	
				DEPTH (m)	TYPE	15	15						15
1.00	150 MM		Medium dense Yellowish brown clayey Sand	1.50/ 2.10	SPT 1	03	07	09	11	16			
2.00													
3.00													
4.00													
5.00													
6.00													
7.00													
8.00													
9.00													
10.00													
				SC	9.00/ 9.60	SPT 6	08	13	17	18	30		

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1 : 50
 JOB NO. : 0400

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR
INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 2 OF 2 DATE : 24/06/2012 TO 29/06/2012

BORE HOLE NO: BH-2 MIDWAY OF BASWA RIVER METHOD : ROTARY DRILLING

LOCATION : BASWA RIVER CASING : Up to 8.00M BGL

CO-ORDINATES: E 812512; N 2449721 DIAMETER : 150 MM AND NX

GROUND W. T. : 0.0 M REDUCED LEVEL: 191.25 M

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15				
10.00	NX	▽	Grey, BASALT	10.00	CORE				58	48	1079
11.00				11.00	CORE				68	51	
12.00				12.00	CORE				56	56	
13.00		▽		13.00							

BORE HOLE IS TERMINATED AT 13.00M BGL

14.00
15.00
16.00
17.00
18.00
19.00
20.00

SPT N = STANDARD PENETRATION TEST VALUE

K = INSITU PERMEABILITY

CR = CORE RECOVERY

UDS = UNDISTURBED SOIL SAMPLE

DS = DISTURBED SOIL SAMPLE

RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 13.00M BGL

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50

JOB NO. : 0400

CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 2						DATE : 08/08/2012 TO 11/08/2012					
BORE HOLE NO: BH-1 BANK OF SELDA NALLAH						METHOD : ROTARY DRILLING					
LOCATION : SELDA NALLAH						CASING : 150MM = 4.50M					
CO-ORDINATES : E 590799;N 2439629						DIAMETER : 150 MM AND NX					
GROUND W. T. : 3.00 M						REDUCED LEVEL: 263.25M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD (%)	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
0.00/0.50			Black cotton soil	0.00/0.50	DS								
1.50/2.10			Loose to Medium dense Brownish yellow Silty Sand	1.50/2.10	SPT 1	2	3	5	7	8			
3.00/3.45				3.00/3.45	SPT 2	4	9	13	-	-			
4.50/4.75				4.50/4.75	SPT 3	5	-	-	-	R			
6.00/6.05			Yellowish brown completely weathered rock	6.00/6.05	SPT 4	52	-	-	-	R			
7.50					CORE						14	NIL	
8.50					CORE						28	NIL	999
9.50			Grey BASALT.		CORE						36	10	
9.50					CORE						51	51	1028

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : **PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.**

SCALE : 1:50
JOB NO. : 0400

CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 2 OF 2					DATE : 08/08/2012 TO 11/08/2012						
BORE HOLE NO: BH-1 BANK OF SELDA NALLAH					METHOD : ROTARY DRILLING						
LOCATION : SELDA NALLAH					CASING : 150MM = 4.50M						
CO-ORDINATES: E 590799:N 2439629					DIAMETER : 150 MM AND NX						
GROUND W. T. : 3.00 M					REDUCED LEVEL: 263.25M						
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm		SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15				
11.00	NX	▽▽ ▽▽ ▽▽ ▽▽ ▽▽ ▽▽	Grey BASALT.	11.00	CORE				51	51	
12.00					CORE					52	52
12.50											
13.00	BORE HOLE IS TERMINATED AT 12.50 M BGL										
14.00											
15.00											
16.00											
17.00											
18.00											
19.00											
20.00											
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UCS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION											
REMARKS : BORE HOLE IS TERMINATED AT 12.50 M BGL										SCALE : 1:50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400	

CLIENT : NTPC LIMITED													
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 1 OF 1					DATE : 16/07/2012 TO 18/07/2012								
BORE HOLE NO: BH-1 Bank of Canal					METHOD : ROTARY DRILLING								
LOCATION : CANAL					CASING : Up to 3.00 m BGL								
CO-ORDINATES: E 607793;N 2446222					DIAMETER : 150 MM AND NX								
GROUND W. T. : 5.60M					REDUCED LEVEL: 216.75M								
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM	+	Brown silty sand	SM	DS1								
2.00			1.50/ 1.80	SPT 1	53	-	-	-	R				
3.00			SM	Brownish yellow Completely weathered rock	3.00/ 3.08	SPT 2	54	-	-	R			
4.00					4.50								
5.00	NX	▽		4.50/ 4.50	SPT 3	58	-	-	-	R			
6.00			CORE					31	07	132			
7.00													
8.00													
9.00			Grey BASALT										
10.00													
BORE HOLE IS TERMINATED AT 9.00M BGL													
SPT N = STANDARD PENETRATION TEST VALUE											CR = CORE RECOVERY		
UCS = UNDISTURBED SOIL SAMPLE											RQD = ROCK QUALITY DESIGNATION		
REMARKS : BORE HOLE IS TERMINATED AT 9.00M BGL											SCALE : 1: 50		
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.											JOB NO. : 0400		

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 1 OF 2	DATE : 30/04/2012 TO 02/05/2012
BORE HOLE NO: BH-1 Right Bank of Garodiya Nallah	METHOD : ROTARY DRILLING
LOCATION : GARODIYA NALLAH	CASING : Up to 3.00m BGL
CO-ORDINATES: N2443856, E 601078	DIAMETER : 150 MM AND NX
GROUND W. T. : 1.80 m Below GL.	REDUCED LEVEL: 198.25M

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	150 MM		Brown silty Sand SM		DS1							
2.00				1.50/ 1.70	SPT 1	51	-	-	R			
3.00										13	NIL	96
4.00			Yellowish brown Completely weathered rock	3.00/ 3.08	SPT 2	58	-	-	R			
5.00										13	NIL	
6.00	NX			4.50								
7.00				6.00						15	NIL	
8.00												
9.00			Grey BASALT							60	26	144
10.00				7.50								
										70	40	
				9.00								
										65	40	167

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REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE

OR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

SCALE : 1: 50
JOB NO. : 0400

CLIENT : NTPC LIMITED													
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 2 OF 2							DATE : 30/04/2012 TO 02/05/2012						
BORE HOLE NO.: BH-1 Right Bank of Garodiya Nallah							METHOD : ROTARY DRILLING						
LOCATION : GARODIYA NALLAH							CASING : Up to 3.00 m BGL						
CO-ORDINATES : N2443866, E 601078							DIAMETER : 150 MM AND NX						
GROUND W. T. : 1.80m Below GL.							REDUCED LEVEL: 198.25M						

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)	
				DEPTH (m)	TYPE	15	15						15
11.00	NX	▽	Grey BASALT	10.50	CORE					65	40		
12.00		▽			CORE					76	76		
		▽											
		▽											
BORE HOLE IS TERMINATED AT 12.00M BGL													
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													
19.00													
20.00													

SPT N = STANDARD PENETRATION TEST VALUE	K = INSITU PERMEABILITY	CR = CORE RECOVERY
UDS = UNDISTURBED SOIL SAMPLE	DS = DISTURBED SOIL SAMPLE	RQD = ROCK QUALITY DESIGNATION
REMARKS : BORE HOLE IS TERMINATED AT 12.00M BGL		
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.		
		SCALE : 1 : 50 JOB NO. : 0400

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 1 OF 2	DATE : 28/08/2012 TO 03/09/2012
BORE HOLE NO: BH-2 MIDWAY OF GARODIYA NALLAH	METHOD : ROTARY DRILLING
LOCATION : GARODIYA NALLAH	CASING : Up to 1.50 m BGL
CO-ORDINATES: E 601054;N 2443872	DIAMETER : 150 MM AND NX
GROUND W. T. : 0.0 M	REDUCED LEVEL: 197.60M

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	150 MM		filledup material	1.00								
2.00		+	Yellowish brown weathered BASALT rock	1.50	CORE					28	NIL	
3.00		+		3.00	CORE					25	NIL	82
4.00		+		4.50	CORE					25	8	
5.00		▽	Grey BASALT	5.00	CORE					39	13	
6.00		▽	Brown BASALT	6.00	CORE					39	23	143
7.00		▽		7.50	CORE					41	25	
8.00		▽	Grey BASALT	8.00	CORE					59	57	158
9.00		▽		9.00	CORE							
10.00		▽										

SPT N = STANDARD PENETRATION TEST VALUE	CR = CORE RECOVERY
UCS = UNDISTURBED SOIL SAMPLE	RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

SCALE : 1: 50

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

JOB NO. : 0400

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED												
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS												
SHEET NO. : 2 OF 2					DATE : 28/08/2012 TO 03/09/2012							
BORE HOLE NO. : BH-2 MIDWAY OF GARODIYA NALLAH					METHOD : ROTARY DRILLING							
LOCATION : GARODIYA NALLAH					CASING : Up to 1.50 m BGL							
CO-ORDINATES : E 601054;N 2443872					DIAMETER : 150 MM AND NX							
GROUND W. T. : 0.0 M					REDUCED LEVEL: 197.60M							
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15			
11.00	NX	▽	Grey BASALT.	10.50	CORE					59	57	
12.00				CORE					60	53		
13.00			BORE HOLE IS TERMINATED AT 12.00M BGL									
14.00												
15.00												
16.00												
17.00												
18.00												
19.00												
20.00												
SPT N = STANDARD PENETRATION TEST VALUE					K = INSITU PERMEABILITY					CR = CORE RECOVERY		
UOS = UNDISTURBED SOIL SAMPLE					DS = DISTURBED SOIL SAMPLE					RQD = ROCK QUALITY DESIGNATION		
REMARKS : BORE HOLE IS TERMINATED AT 12.00M BGL											SCALE : 1:50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.											JOB NO. : 0400	

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED											
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR											
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 2						DATE : 01/05/2012 TO 04/05/2012					
BORE HOLE NO: BH-3 Lt Bank of Garodiya Nallah						METHOD : ROTARY DRILLING					
LOCATION : GARODIYA NALLAH						CASING : Up to 3.00 m BGL					
CO-ORDINATES: E 601031; N 2443864						DIAMETER : 150 MM AND NX					
GROUND W. T. : 5.80m Below GL.						REDUCED LEVEL: 197.92M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM		SM		DS1								
2.00													
3.00													
1.50/1.70			Yellowish brown silty sand mixed with gravels	SM	SPT 1	09	53	-	-	R			
3.00/3.08					SPT 2	58	-	-	-				
4.00					CORE					08	NIL		
4.50					CORE								
5.00					CORE					14	NIL	80	
6.00			Yellowish brown weathered BASALT ROCK										
7.00					CORE					36	NIL		
7.50													
8.00					CORE					18	NIL		
9.00													
9.00			Grey BASALT		CORE					53	35	153	

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 OR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
 JOB NO. : 0400

CLIENT : NTPC LIMITED													
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR													
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 2 OF 2					DATE : 01/05/2012 TO 04/05/2012								
BORE HOLE NO: BH-3 Lt Bank of Garodiya Nallah					METHOD : ROTARY DRILLING								
LOCATION : GARODIYA NALLAH					CASING : Up to 3.00 m BGL								
CO-ORDINATES: E 601031; N 2443864					DIAMETER : 150 MM AND NX								
GROUND W. T. : 5.80m Below GL.					REDUCED LEVEL: 197.92M								
DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15	15				
11.00	NX	▽	Grey BASALT	10.50	CORE						53	35	
12.00					CORE						46	10	
13.00					CORE						65	30	171
14.00					CORE						86	86	
15.00					CORE								
16.00	BORE HOLE IS TERMINATED AT 15.00M BGL												
17.00													
18.00													
19.00													
20.00													
SPT N = STANDARD PENETRATION TEST VALUE										K = INSITU PERMEABILITY		CR = CORE RECOVERY	
UDS = UNDISTURBED SOIL SAMPLE										DS = DISTURBED SOIL SAMPLE		RQD = ROCK QUALITY DESIGNATION	
REMARKS : BORE HOLE IS TERMINATED AT 15.00M BGL												SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.												JOB NO. : 0400	

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 1 OF 1	DATE : 07/08/2012 TO 10/08/2012
BORE HOLE NO: BH-1	METHOD : ROTARY DRILLING
LOCATION : SANAWAD PUNASA ROAD CROSSING	CASING : 150MM = 3.50M
CO-ORDINATES : E 614662 ; N 2451533	DIAMETER : 150 MM AND NX
GROUND W. T. : 7.00M	REDUCED LEVEL: 211.40 M

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD (%)	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM	+	Yellowish brown completely weathered rock	1.50/ 1.75	SPT 1	18	51	-	-	R			
2.00													
3.00				3.00/ 3.50	SPT 2	52	-	-	-	R			
4.00	NX	▽	Grey Fractured BASALT	5.00	CORE					27	NIL	87	
5.00				6.00	CORE					30	NIL		
6.00				7.00	CORE					62	NIL		
7.00			Grey BASALT	8.00	CORE					51	51	125	
8.00		▽		8.50	CORE					67	67		
9.00				10.00	CORE								
10.00													

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BOREHOLE TERMINATED AT 10.00M DEPTH BGL.

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1: 50
JOB NO. : 0400

CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 2						DATE : 07/06/2012 TO 08/06/2012					
BORE HOLE NO: BH-1						METHOD : ROTARY DRILLING					
LOCATION : KHANDWA INDORE ROAD CROSSING						CASING : Up to 7.00 m BGL					
CO-ORDINATES : E 612255; N 2449545						DIAMETER : 150 MM AND NX					
GROUND W. T. : 6.70M						REDUCED LEVEL: 199.25M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m.)	TYPE	15	15	15	15				
0.00/1.00					DS								
1.50/2.10			Very stiff Yellowish brown sandy silty Clay		SPT 1	04	07	9	12	16			
3.00/3.60					SPT 2	07	09	12	14	21			
4.50/5.10	150 MM				SPT 3	08	14	18	24	32			
6.00/6.60					SPT 4	19	21	29	31	50			
7.50/8.10			Medium dense yellowish brown silty Sand		SPT 5	07	09	12	14	21			
9.00/9.60					SPT 6	08	12	14	16	26			

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1:50
 JOB NO. : 0400

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED													
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR													
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 2 OF 2					DATE : 07/08/2012 TO 09/08/2012								
BORE HOLE NO: BH-1					METHOD : ROTARY DRILLING								
LOCATION : KHANDWA INDORE ROAD CROSSING					CASING : Up to 7.00 m BGL								
CO-ORDINATES: E 612255;N 2449545					DIAMETER : 150 MM AND NX								
GROUND W. T. : 6.70M					REDUCED LEVEL: 199.25M								
DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE				BLOWS/15cm	SPT N	CORE RECOVERY (%)	ROQ %	UCS (NO BQOM)	
				DEPTH (m)	TYPE	15	15						15
11.00	150 MM		Medium to dense Yellowish brown silty Sand	10.50/ 11.10	SPT 7	08	12	13	15	25			
12.00				12.00/ 12.60	SPT 8	09	18	21	25	39			
13.00													
14.00				13.50/ 13.95	SPT 9	11	19	21	40				
15.00				15.00/ 15.30	SPT 10	12	22	29	26	51			
16.00													
17.00				16.50/ 17.10	SPT 11	17	21	31	33	52			
18.00				18.00/ 18.60	SPT 12	21	27	32	36	59			
19.00													
20.00				19.50/ 20.10	SPT 13	25	32	38	42	70			
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UCS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE ROQ = ROCK QUALITY DESIGNATION													
REMARKS : BORE HOLE IS TERMINATED AT 20.00M BGL													
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.													
SCALE : 1:50 JOB NO. : 0400													

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED													
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 1 OF 2					DATE : 10/09/2012 TO 13/09/2012								
BORE HOLE NO: BH-1 BANK OF CANAL					METHOD : ROTARY DRILLING								
LOCATION : CANAL					CASING : 150MM = 3.00M								
CO-ORDINATES: E 815063; N 2453219					DIAMETER : 150 MM AND NX								
GROUND W. T. : NMW					REDUCED LEVEL: 224.50M								
DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD (%)	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM		Brown silty Sand	1.00	DS								
2.00				1.50/1.75	SPT 1	18	51	-	-	R			
3.00					CORE						13	NIL	
4.00				3.00/3.05	SPT 2	51	-	-	-	R			
5.00					CORE						18	NIL	99
6.00			Yellowish brown weathered Rock	4.50/4.8	SPT 3	5	-	-	-	R			
7.00					CORE						19	NIL	
8.00				6.00/6.05	SPT 4	54	-	-	-	R			
9.00					CORE						24	NIL	
10.00				7.50	CORE						18	NIL	
			Grey fractured BASALT	9.00	CORE						29	NIL	855
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE										CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION			
REMARKS : PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										SCALE : 1:50 JOB NO. : 0400			

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED												
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR												
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS												
SHEET NO. : 1 OF 2						DATE : 05/07/2012 TO 11/07/2012						
BORE HOLE NO: BH-1 Bank of Khedi River						METHOD : ROTARY DRILLING						
LOCATION : KHEDI RIVER						CASING : Up to 3.00 m BGL						
CO-ORDINATES: E 613034;N 2450251						DIAMETER : 150 MM AND NX						
GROUND W. T. : 4.50 M BGL						REDUCED LEVEL: 196.75M						
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	150 MM		Brown silty Sand		OS1							
2.00				1.50/ 2.10	SPT 1	02	03	05	08	08		
3.00												
3.70				3.00/ 3.60	SPT 2	02	03	05	09	11		
4.00	NX		Grey fractured BASALT	4.50	CORE					42	NIL	
5.00					CORE						23	NIL
6.00					CORE						25	NIL
7.00					CORE						27	NIL
9.00					CORE						54	51
10.00												
SPT N = STANDARD PENETRATION TEST VALUE UDS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION												
REMARKS : BORE HOLE CONTINUES										SCALE : 1:50		
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400		

CLIENT : NTPC LIMITED										
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS										
SHEET NO. : 2 OF 2					DATE : 05/07/2012 TO 11/07/2012					
BORE HOLE NO: BH-T Bank of Khedi River					METHOD : ROTARY DRILLING					
LOCATION : KHEDI RIVER					CASING : Up to 3.00 m BGL					
CO-ORDINATES: E 813034;N 2450251					DIAMETER : 150 MM AND NX					
GROUND W. T. : 4.50M					REDUCED LEVEL: 196.75M					
DEPTH (m.)	DIA OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm		CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15			
11.00	NX	▽ ▽ ▽ ▽ ▽ ▽ ▽	Grey, BASALT	10.50	CORE			54	51	1362
12.00					CORE			50	50	
BORE HOLE IS TERMINATED AT 12.00M BGL										
13.00										
14.00										
15.00										
16.00										
17.00										
18.00										
19.00										
20.00										
SPT N = STANDARD PENETRATION TEST VALUE K = INSITU PERMEABILITY CR = CORE RECOVERY UCS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE RQD = ROCK QUALITY DESIGNATION										
REMARKS : BORE HOLE IS TERMINATED AT 12.00M BGL									SCALE : 1: 50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.									JOB NO. : 0400	

CLIENT : NTPC LIMITED											
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 1						DATE : 28/08/2012 TO 03/07/2012					
BORE HOLE NO: BH-2 Midway of Khedi river						METHOD : ROTARY DRILLING					
LOCATION : KHEDI RIVER						CASING : Up to 1.50 m BGL					
CO-ORDINATES: E 613063; N 2450285						DIAMETER : 150 MM AND NX					
GROUND W. T. : 6.0 M						REDUCED LEVEL: BL 194.75M					
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE DEPTH (m)	TYPE	BLOWS/15cm	SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)	
1.00	150 MM		Brown silty Sand SM	1.00	DS1						
2.00				2.50							
3.00				2.50/2.58	SPT 1	51	-	-	-	-	
4.00			Grey fractured BASALT	4.00							
5.00	NX			4.00/4.05	SPT 2	3	-	-	-	-	
6.00				5.50							
7.00				7.00							
8.00			Grey BASALT	8.50							
9.00											
10.00				10.00							
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION											
REMARKS : BORE HOLE IS TERMINATED AT 10.00M BGL										SCALE : 1:50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400	

CLIENT : NTPC LIMITED										
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR										
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS										
SHEET NO. : 1 OF 1					DATE : 20/04/2012 TO 22/04/2012					
BORE HOLE NO: BH-1 Right Bank of Sheetal River					METHOD : ROTARY DRILLING					
LOCATION : SHEETAL RIVER					CASING : Up to 4.00 m BGL					
CO-ORDINATES: E 600368; N 2443880					DIAMETER : 150 MM AND NX					
GROUND W. T. : 4.00m Below GL.					REDUCED LEVEL: 194.91M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15				
1.00	150 MM		Medium dense Yellowish brown silty Sand		DS1							
2.00												
2.50				SPT 1	04	06	09	11				
3.00												
4.00												
5.00	NX		Grey, BAULT		CORE				31	15	596	
6.00					CORE				73	40		
7.00					CORE				60	60	718	
8.00					CORE				70	50		
9.00												
BORE HOLE IS TERMINATED AT 9.00M BGL												
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION												
REMARKS : BORE HOLE IS TERMINATED AT 9.00M BGL										SCALE : 1: 50		
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.										JOB NO. : 0400		

CLIENT : NTPC LIMITED

PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS

SHEET NO. : 1 OF 2

DATE : 27/08/2012 TO 02/09/2012

BORE HOLE NO: BH-2 Midway of Sheetal River

METHOD : ROTARY DRILLING

LOCATION : SHEETAL RIVER

CASING : Up to 3.00 m BGL

CO-ORDINATES: E 600390; N 2443883

DIAMETER : 150 MM AND NX

GROUND W. T. : 0.0 m

REDUCED LEVEL: BL 194.15M

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KD ISCM)
				DEPTH (m)	TYPE	15	15	15	15				
1.00		▽									22	15	
		▽		1.50									
2.00		▽		1.50/ 1.55	SPT 1	50	-	-	-	R			
		▽									23	8	839
3.00		▽		3.00									
		▽		3.00/ 3.04	SPT 2	50	-	-	-				
4.00		▽									29	NIL	
		▽		4.50									
5.00	NX	▽	Grey fractured BASALT								27	16	
		▽		6.00									
7.00		▽									23	9	
		▽		7.50									
8.00		▽									31	14	959
		▽		9.00									
9.00		▽	Grey BASALT.								50	50	
		▽											
10.00		▽											

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE

CR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE CONTINUES

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1:50
JOB NO. : 0400

BORE HOLE IS TERMINATED AT 12.00M BGL

CLIENT : NTPC LIMITED													
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR													
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 1 OF 1						DATE : 24/04/2012 TO 27/04/2012							
BORE HOLE NO. : BH-3 Left Bank of Sheetal River						METHOD : ROTARY DRILLING							
LOCATION : SHEETAL RIVER						CASING : Up to 5.00 m BGL							
CO-ORDINATES : E 600407; N 2443890						DIAMETER : 150 MM AND NX							
GROUND W. T. : 5.00m Below GL.						REDUCED LEVEL: 194.49M							
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	100 MM		Medium dense Brownish silty sand		DS1								
2.00				1.50/ 2.10	SPT 1	02	04	06	06	10			
3.00													
3.00				3.00	SPT 2	04	08	11	04				
4.00													
5.00				4.50	SPT 3	05	11	14	08	R			
5.00			5.00										
6.00	NX		Grey fractured BASALT	6.00	CORE					15	NIL		
7.00				CORE					50	26	760		
8.00				CORE					53	28	837		
9.00				CORE					60	50			
10.00			10.00										

SPT N = STANDARD PENETRATION TEST VALUE
 UCS = UNDISTURBED SOIL SAMPLE
 CR = CORE RECOVERY
 RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 10.00M BGL

PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.

SCALE : 1:50
 JOB NO. : 0400

CLIENT : NTPC LIMITED											
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR											
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 1						DATE : 07/05/2012 TO 08/05/2012					
BORE HOLE NO: BH-1 Rt Bank of Canal						METHOD : ROTARY DRILLING					
LOCATION : CANAL						CASING : Up to 1.50 m BGL					
CO-ORDINATES: E 506744;N 2441844						DIAMETER : 150 MM AND NX					
GROUND W. T. : Not Encountered						REDUCED LEVEL: 227.25M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 MM		Brown silty Sand										
1.50													
2.00	NX		Brown to grey BASALT	1.50	SPT 1	58	-	-	-	R	50	10	837
2.50													
3.00													
4.00													
5.00													
5.50													
6.00													
7.00													
7.50													
8.00													
9.00													
10.00													
BORE HOLE IS TERMINATED AT 7.00M BGL													
SPT N = STANDARD PENETRATION TEST VALUE												CR = CORE RECOVERY	
UCS = UNDISTURBED SOIL SAMPLE												RQD = ROCK QUALITY DESIGNATION	
REMARKS : BORE HOLE IS TERMINATED AT 7.00M BGL												SCALE : 1:50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.												JOB NO. : 0400	

CLIENT : NTPC LIMITED											
CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR											
PROJECT : INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS											
SHEET NO. : 1 OF 1						DATE : 07/05/2012 TO 09/05/2012					
BORE HOLE NO: BH-2 Lt Bank of Canal						METHOD : ROTARY DRILLING					
LOCATION : CANAL						CASING : Up to 1.00 m BGL					
CO-ORDINATES: E 506517; N 2441788						DIAMETER : 150 MM AND NX					
GROUND W. T. : Not Encountered						REDUCED LEVEL: 224.85 M					

DEPTH (m.)	DIA. OF BORE HOLE	LOG	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm			SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/ISCM)
				DEPTH (m)	TYPE	15	15	15				
1.00	150 MM		Yellowish brown silty Sand	1.00	DS1							
2.00			Yellow fractured BASALT	2.00	SPT 1	58	-	-	-	15	NIL	80
2.05				2.05						18	NIL	
3.00				3.00								
4.00				4.00						15	NIL	
4.50	NX			4.50								
5.00			Grey BASALT									
6.00				6.00						56	40	534
7.00				7.00						83	83	
7.50				7.50								
BORE HOLE IS TERMINATED AT 7.50M BGL												
8.00												
9.00												
10.00												

SPT N = STANDARD PENETRATION TEST VALUE
UCS = UNDISTURBED SOIL SAMPLE
OR = CORE RECOVERY
RQD = ROCK QUALITY DESIGNATION

REMARKS : BORE HOLE IS TERMINATED AT 7.50M BGL
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.
SCALE : 1: 50
JOB NO. : 0400

CLIENT : NTPC LIMITED													
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS													
SHEET NO. : 1 OF 1						DATE : 11/05/2012 TO 13/05/2012							
BORE HOLE NO: BH-1						METHOD : ROTARY DRILLING							
LOCATION : SELDA BEDIA ROAD CROSSING						CASING : Up to 0.50 m BGL							
CO-ORDINATES: E 505601;N 2441664						DIAMETER : 150 MM AND NX							
GROUND W. T. : Not Encountered						Reduced Level : 230.55 M							
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CORE RECOVERY (%)	RQD %	UCS (KG/CM ²)
				DEPTH (m)	TYPE	15	15	15	15				
0.50	150 MM	III	Brown silty Sand	0.50	DS1								
1.00	NX	▽	Grey fractured BASALT	1.50	CORE					25	NIL		
2.00			CORE					48	396				
3.00			CORE					43					
4.00			CORE					94	94				
5.00			Grey BASALT	3.50									
5.00			BORE HOLE TERMINATED AT 5.00M BGL										
6.00													
7.00													
8.00													
9.00													
10.00													
SPT N = STANDARD PENETRATION TEST VALUE												CR = CORE RECOVERY	
UCS = UNDISTURBED SOIL SAMPLE												RQD = ROCK QUALITY DESIGNATION	
REMARKS : BORE HOLE IS TERMINATED AT 5.00M BGL												SCALE : 1:50	
PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.												JOB NO. : 0400	

CLAUSE NO.

TECHNICAL REQUIREMENTS



CLIENT : NTPC LIMITED										
PROJECT : CONSULTANCY WORK FOR PRELIMINARY GEOTECH INVESTIGATION FOR										
INTAKE WELL LOCATION & MUW PIPE CORRIDOR FOR KHARGONE STPS										
SHEET NO. : 1 OF 2					DATE : 20/07/2012 TO 23/07/2012					
BORE HOLE NO: BH-1 Bank of Canal					METHOD : ROTARY DRILLING					
LOCATION : CANAL					CASING : Up to 2.50M BGL					
CO-ORDINATES: E 604871; N 2443621					DIAMETER : 150 MM AND NX					
GROUND W. T. : 6.50M					REDUCED LEVEL: 231.35M					
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm		CORE RECOVERY (%)	RQD (%)	UCS (KG/BSQM)
				DEPTH (m)	TYPE	15	15			
1.00	NX	+	Yellowish brown weathered basalt rock		CORE			18	NIL	80
		1.50								
2.00				CORE				22	NIL	
		2.50								
3.00				CORE				28	NIL	
		4.00								
5.00				CORE				28	NIL	
		5.50								
6.00				CORE				23	NIL	
		7.00								
8.00		CORE				23	NIL	258		
	8.50									
9.00		CORE				55	NIL			
10.00		▽	Yellowish brown BASALT		CORE			55	55	355
SPT N = STANDARD PENETRATION TEST VALUE UCS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY RQD = ROCK QUALITY DESIGNATION										
REMARKS : PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD.								SCALE : 1:50 JOB NO. : 0400		

12.00

13.00

14.00

15.00

16.00

17.00

18.00

19.00

BORE HOLE IS TERMINATED AT 12.00M BGL

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CLAUSE NO.	TECHNICAL REQUIREMENTS			एन टी पी सी NTPC								
	ANNEXURE- (d) CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – B for site specific information. Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard. Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method. Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz. Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards. It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects. Damping in Structures The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for: <table><tr><td>a) Welded steel structures</td><td>: 1.0%</td></tr><tr><td>b) Bolted steel structures</td><td>: 2.0%</td></tr><tr><td>c) Reinforced concrete structures</td><td>: 1.6%</td></tr><tr><td>d) Steel stacks</td><td>: As per IS:6533 & CICIND Model Code whichever is more critical.</td></tr></table>				a) Welded steel structures	: 1.0%	b) Bolted steel structures	: 2.0%	c) Reinforced concrete structures	: 1.6%	d) Steel stacks	: As per IS:6533 & CICIND Model Code whichever is more critical.
a) Welded steel structures	: 1.0%											
b) Bolted steel structures	: 2.0%											
c) Reinforced concrete structures	: 1.6%											
d) Steel stacks	: As per IS:6533 & CICIND Model Code whichever is more critical.											
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CLAUSE NO.	TECHNICAL REQUIREMENTS एनडीपीसी NTPC		
	ANNEXURE-D1 SITE SPECIFIC DESIGN PARAMETERS The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows: a) The basic wind speed “V_b” at ten metres above the mean ground level : 39 metres/second b) The risk coefficient “K_1” : 1.06 c) Category of terrain : Category-2 Note: Notwithstanding the values of the above mentioned parameters, the design wind pressure so computed at any point shall not be taken less than 1500 N/Sq. metre for all classes of structures, i.e. A, B & C, as defined in IS: 875 (Part-3).		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC																
	Annexure-(e) CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1):2002 and IS:1893 (Part 4):2005. Pending finalisation of Parts 2, 3 and 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for structures other than the buildings and industrial structures including stack-like structures. A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Annexure-E1. Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values. The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Annexure-E1 includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 and Part 4). Damping in Structures The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for: <table><tr><td>a)</td><td>Steel structures</td><td>:</td><td>2%</td></tr><tr><td>b)</td><td>Reinforced Concrete structures</td><td>:</td><td>5%</td></tr><tr><td>c)</td><td>Reinforced Concrete Stacks</td><td>:</td><td>3%</td></tr><tr><td>d)</td><td>Steel stacks</td><td>:</td><td>2%</td></tr></table>				a)	Steel structures	:	2%	b)	Reinforced Concrete structures	:	5%	c)	Reinforced Concrete Stacks	:	3%	d)	Steel stacks	:	2%
a)	Steel structures	:	2%																	
b)	Reinforced Concrete structures	:	5%																	
c)	Reinforced Concrete Stacks	:	3%																	
d)	Steel stacks	:	2%																	
KHARGONE STPP (2X660MW) EPC PACKAGE		TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 366 OF 393																

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	Method of Analysis Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1). In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1). For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B / V_B$. However, no reduction is permitted if $\bar{V}_B$ is less than V_B. For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (A_h) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Annexure-E1. Further, the spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the building falls to the left of the peak in the spectral acceleration curve. Design/Detailing for Ductility for Structures The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	ANNEXURE – E1 SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT The various site specific seismic parameters for the project site shall be as follows: 1) Peak ground horizontal acceleration (MCE) : 0.16 g 2) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra a) for ordinary moment resisting steel frames designed and detailed as per IS:800 : 0.047 b) for braced steel frames designed and detailed as per IS:800 : 0.035 c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.028 d) for steel chimney : 0.070 e) for design of structures not covered under 2 (a) to 2 (d) above and under 3 below : 0.047 3) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.094 Note: g = Acceleration due to gravity The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.		
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HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1	1.00	1.000
0.03	1	1.00	1.000
0.04	1.411	1.328	1.260
0.05	1.842	1.654	1.508
0.06	2.291	1.979	1.746
0.07	2.755	2.304	1.976
0.08	3.232	2.628	2.200
0.089	3.670	2.919	2.397
0.09	3.670	2.950	2.419
0.1	3.670	3.175	2.500
0.11	3.670	3.175	2.500
0.115	3.670	3.175	2.500
0.12	3.670	3.175	2.500
0.125	3.670	3.175	2.500
0.13	3.670	3.175	2.500
0.135	3.670	3.175	2.500
0.14	3.670	3.175	2.500
0.145	3.670	3.175	2.500
0.15	3.670	3.175	2.500
0.2	3.670	3.175	2.500
0.25	3.670	3.175	2.500
0.3	3.670	3.175	2.500
0.33	3.670	3.175	2.500
0.336	3.670	3.175	2.500
0.35	3.670	3.175	2.500
0.36	3.670	3.175	2.500
0.37	3.670	3.175	2.500
0.38	3.670	3.175	2.500
0.39	3.670	3.175	2.500
0.4	3.670	3.175	2.500
0.41	3.415	3.098	2.439
0.43	3.256	2.953	2.326
0.45	3.111	2.822	2.222
0.5	2.800	2.540	2.000
0.55	2.545	2.309	1.818
0.56	2.500	2.268	1.786
0.565	2.478	2.248	1.770

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
 (In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.57	2.456	2.228	1.754
0.575	2.435	2.209	1.739
0.58	2.414	2.190	1.724
0.585	2.393	2.171	1.709
0.59	2.373	2.153	1.695
0.595	2.353	2.134	1.681
0.6	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.7	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.8	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1	1.400	1.270	1.000
1.05	1.333	1.210	0.952
1.1	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.2	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.3	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.4	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.5	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.6	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.7	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.8	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.9	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.1	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.2	0.636	0.577	0.455
2.25	0.622	0.564	0.444

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
2.3	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.4	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.5	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.6	0.538	0.488	0.385
2.67	0.524	0.476	0.375
2.7	0.519	0.470	0.370
2.75	0.509	0.462	0.364
2.8	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.9	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.1	0.452	0.410	0.323
3.15	0.444	0.403	0.317
3.2	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.3	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.4	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.5	0.400	0.363	0.286

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
Annexure-(f)	QA REQUIREMENT All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of this Specification.		
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RAINFALL DATA

Rainfall data by Indian Meteorological Department (IMD) for Khargone (near Selda village & Sanawad town in Barwah tehsil) is attached (from 1969 to 1980) in Project Information part of this specification. For additional data, Bidder has to arrange for necessary input directly from IMD under intimation to the owner.

जलवायवी सारणी CLIMATOLOGICAL TABLE																																																																																																																																																																																																																																																																																																																															
STATION: Khargone					स्थान: खर्गोन					1969 से 1980 तक के जलवायु पर अवलोकन BASED ON OBSERVATIONS FROM 1969 TO 1980																																																																																																																																																																																																																																																																																																																					
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माह	दैनिक अधिकतम तनू	दैनिक न्यूनतम तनू	माह में अधिकतम तनू	माह में न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम तनू	सबसे अधिकतम तनू	सबसे न्यूनतम 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CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC																												
	ANNEXURE – (h)																															
	<u>Specification For High Performance Moisture Compatible Corrosion Resistant Coating System (for Concrete Surfaces of IDCT)</u>																															
	a) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs. The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer’s written recommended shelf life. b) The coating system shall conform to the following : PROPERTIES OF PAINT <table><tr><td>Coating System</td><td>High Performance Moisture Compatible Corrosion Resistant Coating System</td></tr><tr><td>Volume Solids</td><td>70%</td></tr><tr><td>Specific Gravity (ASTM-D-1475)</td><td>1.25 ± 0.1</td></tr><tr><td>Dry Film Thickness (ASTM-D-1186)</td><td>160 ± 10 µm per coat</td></tr><tr><td>Coverage</td><td>4 - 4.5 sq.m/ ltr</td></tr><tr><td>Touch Dry</td><td>2 Hours</td></tr><tr><td>Recoating</td><td>24 Hours</td></tr></table> PROPERTIES OF COATING <table><tr><td>Salt Spray (ASTM-B 117)</td><td>2000 Hour</td></tr><tr><td>Resistance to sea water (Carried out up o 6 mont s)</td><td>Passes</td></tr><tr><td>Coating Resistance (Carried out upto 6 months)</td><td>10⁹ Ω. cm²</td></tr><tr><td>Ad esion (ASTM-D 4541)</td><td>4.5 kN minimu</td></tr><tr><td>Flexibility (ASTM-D-522)</td><td>1/8" passes</td></tr><tr><td>Elo gation</td><td>33%</td></tr><tr><td>Impact (ASTM G 14–04)</td><td>45 cm passes</td></tr></table>				Coating System	High Performance Moisture Compatible Corrosion Resistant Coating System	Volume Solids	70%	Specific Gravity (ASTM-D-1475)	1.25 ± 0.1	Dry Film Thickness (ASTM-D-1186)	160 ± 10 µm per coat	Coverage	4 - 4.5 sq.m/ ltr	Touch Dry	2 Hours	Recoating	24 Hours	Salt Spray (ASTM-B 117)	2000 Hour	Resistance to sea water (Carried out up o 6 mont s)	Passes	Coating Resistance (Carried out upto 6 months)	10 ⁹ Ω. cm ²	Ad esion (ASTM-D 4541)	4.5 kN minimu	Flexibility (ASTM-D-522)	1/8" passes	Elo gation	33%	Impact (ASTM G 14–04)	45 cm passes
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KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 374 OF 393																													

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
	Annexure-(i)			
	List of tender drawings attached with this specification include			
	SI No.	Title	Drg No.	
	1)	General Layout Plan	9578-999-POC-F-001- Rev. 1	
	2)	Site Levelling Works	9578-001(R)-POC-A-001- Rev. A	
	3)	General Arrangement and Detail of WT, S/R & Tunnel.	9578-001(R)-POC-A-003 - Rev. A	
	4)	Topographical Survey Detail	9578-001(R)-PVC-A-001 – Rev. 0	
	5)	Hydrographic Survey Details For Intake Water Pump House In Submergence Of Omkareshwar Dam	9578-001(R)-PVC-C-A-003–Rev.01	
	6)	Preliminary Topographical Survey of the Make Up Water Pipeline Corridor	9578-001(R)-PVC-C-A-004-SHEET -1 TO 12 Rev.01	
	7)	Make-Up Water Pipe Line Crossings	9578-001(R)-PVC-A-005. Rev. A	
	8)	Owner’s Construction Office – Architectural Details	9578-001(R)-POC-A-006	
KHARGONE STPP (2X660MW) EPC PACKAGE		TECHNICAL SPECIFICATION		SUB-SECTION- CIVIL WORKS
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CLAUSE NO.

TECHNICAL REQUIREMENTS



ELECTRICAL RESISTIVITY TEST

IS : 1892

Project Preliminary Geotechnical Investigations for Main Plant, and Allied Areas, for proposed Super Thermal Power Project (2 X 660 MW)
in Khargone Dist. Of MP

Clients NTPC Limited

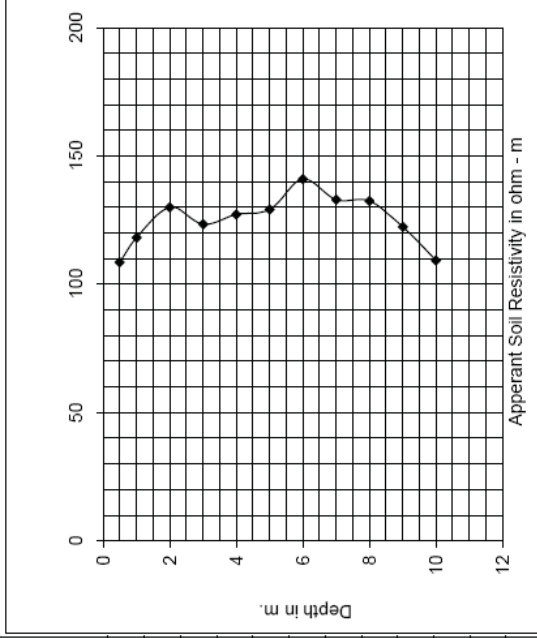
Test No. ERT 2

Co - Ordinate E : 587793 N : 2440400

Survey Method : Wenner's Four Pin equal Probe spacing

Date : 12.04.2011
Current : 7 Amp.
Voltage : 50

Serial	Electrode spacing, a	Resistance R	Apparent soil Resistivity $\rho = 2 \pi a$	Resistance R	Apparent soil Resistivity $\rho = 2 \pi a$	Apparent soil Resistivity $\rho = 2 \pi a$
No.	Mtrs.	ohm	ohm-m	ohm	ohm-m	ohm-m
1	0.5	33.400	104.93	35.700	112.15	108.54
2	1	18.200	114.35	19.400	121.89	118.12
3	2	10.400	130.69	10.300	129.43	130.06
4	3	6.000	113.10	7.100	133.83	123.46
5	4	4.460	112.09	5.660	142.25	127.17
6	5	3.930	123.46	4.290	134.77	129.12
7	6	3.380	127.42	4.100	154.57	140.99
8	7	2.870	126.23	3.180	139.86	133.05
9	8	2.510	126.17	2.760	138.73	132.45
10	9	2.200	124.41	2.130	120.45	122.43
11	10	1.910	120.01	1.570	98.65	109.33



PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD., MUMBAI

Job No. 0300
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KHARGONE TPP
(2X660MW)
EPC PACKAGE

TECHNICAL SPECIFICATION

SUB-SECTION-
CIVIL WORKS

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CLAUSE NO.

TECHNICAL REQUIREMENTS



ELECTRICAL RESISTIVITY TEST

IS : 1892

Project Preliminary Geotechnical Investigations for Main Plant, and Allied Areas, for proposed Super Thermal Power Project (2 X 660 MW)
in Khargoon Dist. Of MP

Clients NTPC Limited

Test No. ERT 4

Co - Ordinate E : 588211 N : 2440408

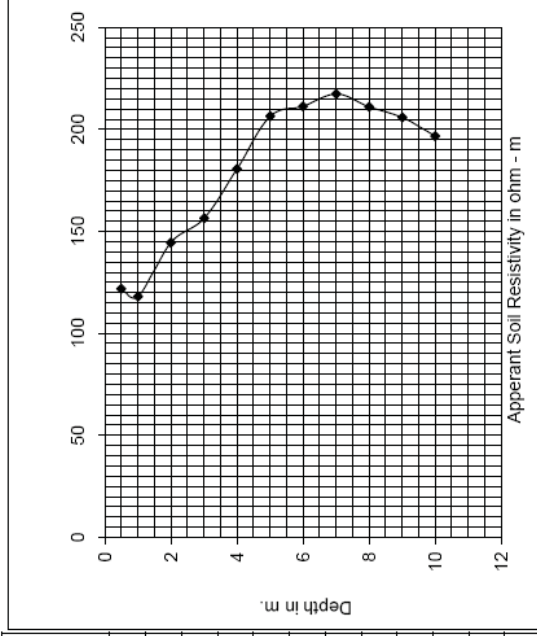
Date : 12.04.2011

Current : 7 Amp.

Voltage : 50

Survey Method : Wenner's Four Pin equal Probe spacing

Serial	Electrode spacing, a	$K = \frac{2\pi a}{\ln 2}$	Resistance R	Apparent soil Resistivity $\rho = \frac{R}{K}$	Resistance R	Apparent soil Resistivity $\rho = \frac{R}{K}$	Apparent soil Resistivity $\rho = \frac{R}{K}$
No.	Mtrs.	Mtrs	ohm	ohm-m	ohm	ohm-m	ohm-m
1	0.5	3.142	39.100	122.84	38.500	120.95	121.89
2	1	6.283	18.400	115.61	19.200	120.64	118.12
3	2	12.566	10.300	129.43	12.700	159.59	144.51
4	3	18.850	7.850	147.97	8.750	164.93	156.45
5	4	25.133	7.110	178.69	7.260	182.46	180.58
6	5	31.416	6.560	206.09	6.580	206.72	206.40
7	6	37.699	5.720	215.64	5.490	206.97	211.30
8	7	43.982	4.950	217.71	4.930	216.83	217.27
9	8	50.265	4.240	213.13	4.160	209.10	211.12
10	9	56.549	3.760	212.62	3.520	199.05	205.84
11	10	62.832	3.230	202.95	3.030	190.38	196.66



PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD., MUMBAI

Job No. 0300
Checked KSP

KHARGONE TPP
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TECHNICAL SPECIFICATION

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CLAUSE NO.

TECHNICAL REQUIREMENTS



ELECTRICAL RESISTIVITY TEST

IS : 1892

Project Preliminary Geotechnical Investigations for Main Plant, and Allied Areas, for proposed Super Thermal Power Project (2 X 660 MW)
in Khargaan Dist. Of MP

Clients NTPC Limited

Test No. ERT 7

Co - Ordinate E : 587965 N : 2440106

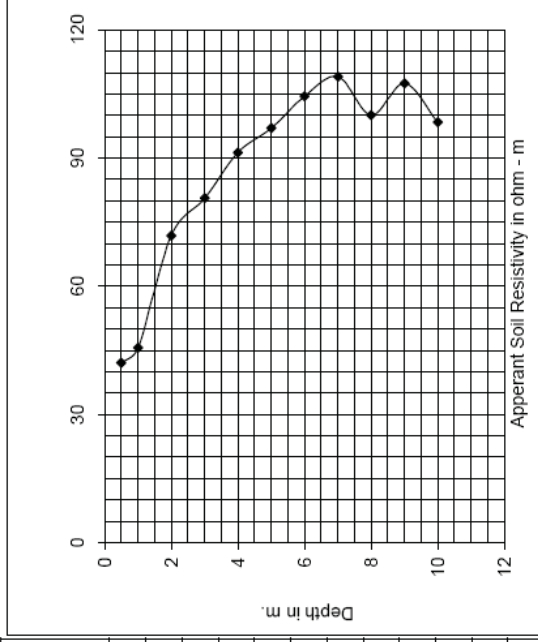
Date : 12.04.2011

Current : 7 Amp.

Voltage : 50

Survey Method : Wenners Four Pin equal Probe spacing

Serial	Electrode spacing, a	$K = 2 \pi a$	Resistanc e R	Apperant soil Resistivity $\rho = 2 \pi a R$	Resistanc e R	Apperant soil Resistivity $\rho = 2 \pi a R$	Apperant soil Resistivity $\rho = 2 \pi a R$
No.	Mtrs.	Mtrs	ohm	ohm-m	ohm	ohm-m	ohm-m
1	0.5	3.142	13.200	41.47	13.600	42.73	42.10
2	1	6.283	7.100	44.61	7.420	46.62	45.62
3	2	12.566	5.790	72.76	5.640	70.87	71.82
4	3	18.850	4.180	78.79	4.380	82.56	80.68
5	4	25.133	3.420	85.95	3.840	96.51	91.23
6	5	31.416	3.030	95.19	3.150	98.96	97.08
7	6	37.699	2.720	102.54	2.820	106.31	104.43
8	7	43.982	2.320	102.04	2.640	116.11	109.08
9	8	50.265	1.970	99.02	2.010	101.03	100.03
10	9	56.549	1.820	102.92	1.980	111.97	107.44
11	10	62.832	1.650	103.67	1.480	92.99	98.33



PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD., MUMBAI

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KHARGONE TPP
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TECHNICAL SPECIFICATION

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CLAUSE NO.

TECHNICAL REQUIREMENTS



ELECTRICAL RESISTIVITY TEST

IS : 1892

Project Preliminary Geotechnical Investigations for Main Plant, and Allied Areas, for proposed Super Thermal Power Project (2 X 660 MW) in Khargone Dist. Of MP

Clients NTPC Limited

Test No. ERT 9

Co - Ordinate E : 587955 N : 2439834

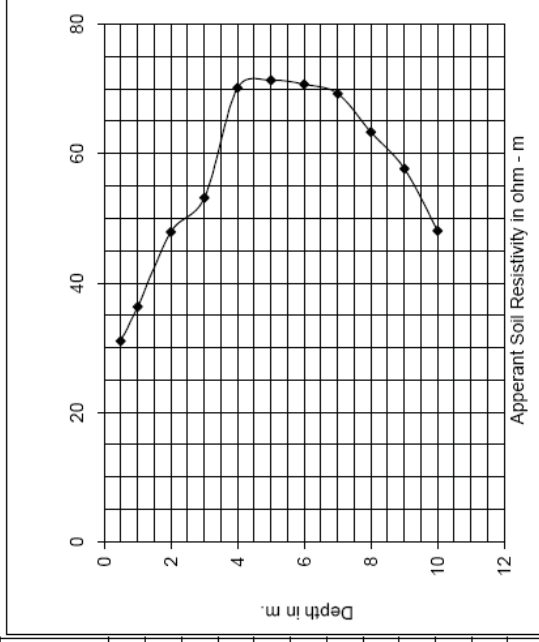
Date : 12.04.2011

Current : 7 Amp.

Voltage : 50

Survey Method : Wenner's Four Pin equal Probe spacing

Serial	Electrode spacing, a	Resistanc e R	Apparent soil Resistivity $\rho = 2 \pi a$ R	Resistanc e R	Apparent soil Resistivity $\rho = 2 \pi a$ R	Apparent soil Resistivity $\rho = 2 \pi a$ R
No.	Mtrs.	ohm	ohm-m	ohm	ohm-m	ohm-m
1	0.5	9.240	29.03	10.500	32.99	31.01
2	1	5.670	35.63	5.890	37.01	36.32
3	2	3.750	47.12	3.870	48.63	47.88
4	3	2.710	51.08	2.930	55.23	53.16
5	4	2.710	68.11	2.870	72.13	70.12
6	5	2.330	73.20	2.210	69.43	71.31
7	6	1.900	71.63	1.850	69.74	70.69
8	7	1.630	71.69	1.520	66.85	69.27
9	8	1.230	61.83	1.290	64.84	63.33
10	9	1.030	58.25	1.010	57.11	57.68
11	10	0.874	54.92	0.657	41.28	48.10



PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD., MUMBAI

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KHARGONE TPP
(2X660MW)
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TECHNICAL SPECIFICATION

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CLAUSE NO.

TECHNICAL REQUIREMENTS



ELECTRICAL RESISTIVITY TEST

IS : 1892

Project Preliminary Geotechnical Investigations for Main Plant, and Allied Areas, for proposed Super Thermal Power Project (2 X 660 MW) in Khargone Dist. Of MP

Clients NTPC Limited

Test No. ERT 12

Co - Ordinate E : 588261 N : 2441221

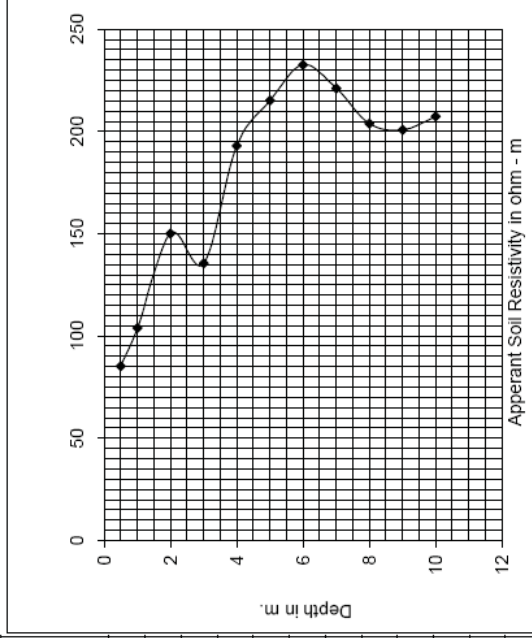
Date : 12.04.2011

Current : 7 Amp.

Voltage : 50

Survey Method : Wenners Four Pin equal Probe spacing

Serial	Electrode spacing, a	$K = \frac{2\pi a}{\ln 2}$	Resistanc e R	Apparent soil Resistivity $\rho = 2\pi a R$	Resistanc e R	Apparent soil Resistivity $\rho = 2\pi a R$	Apparent soil Resistivity $\rho = 2\pi a R$
No.	Mtrs.	Mtrs	ohm	ohm-m	ohm	ohm-m	ohm-m
1	0.5	3.142	28.500	89.54	25.800	81.05	85.29
2	1	6.283	18.400	115.61	14.700	92.36	103.99
3	2	12.566	11.700	147.03	12.200	153.31	150.17
4	3	18.850	6.820	128.55	7.560	142.50	135.53
5	4	25.133	8.870	222.93	6.480	162.86	192.89
6	5	31.416	7.420	233.11	6.280	197.29	215.20
7	6	37.699	6.700	252.58	5.640	212.62	232.60
8	7	43.982	5.460	240.14	4.590	201.88	221.01
9	8	50.265	4.540	228.21	3.570	179.45	203.83
10	9	56.549	4.040	228.46	3.060	173.04	200.75
11	10	62.832	3.750	235.62	2.850	179.07	207.35



PARESH CONSTRUCTIONS AND FOUNDATIONS PVT. LTD., MUMBAI

Job No. 0300
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KHARGONE TPP
(2X660MW)
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TECHNICAL SPECIFICATION

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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	Annexure (k) Site management during construction phase till handing over of plant. Bidder shall ensure that the plant site within the plant boundary is managed in a coordinated and professional way all through the construction phase till handing over of plant, ensuring safe, easy & unhindered working conditions and a healthy & hygienic working environment at site. He shall ensure the following measures at site while executing the project: a) Unhindered motorable road access to all work area and facilities both during the construction/ erection and as they get completed progressively. Required temporary access roads other than the permanent roads shall also be provided. Bidder shall prioritize the construction of approach roads, roads around the main plant block, roads to office & storage areas and the offsite areas from the start of project itself. He shall finalise and submit the complete road layout plan along with priority and completion schedule immediately after the award for review by the engineer-in-charge. He shall ensure that the roads are promptly repaired and maintained against any damages due to movement of traffic/heavy trailers & cranes/rains etc. providing motorable access at all times. Adequate onsite stock of road metal/materials shall be kept and maintained distributed over the site for repairs especially before the monsoon period. Construction of all village diversion roads shall be undertaken in the first phase. b) Proper drainage of rain water, ground water from excavations, water flows from batching plant/construction sites etc. He shall priorities the construction of permanent drains from the start of the project itself. Till such time the permanent drainage network is done, he shall construct adequate temporary drains to ensure that there is no accumulation/stagnation of water in the plant site. Bidder may consider providing precast RCC drains for temporary/ permanent drain construction for faster construction of drains. The drain construction shall be matched with progress of road construction for preventing damage to roads. Bidder shall provide and maintain adequate number of drainage pumps (both electrical and diesel operated) of suitable capacity for pumping out accumulated water especially during the monsoon periods. All drain diversions required shall be undertaken at the start of the project itself. c) The plant site is fully secured against unauthorized access. For the same he shall take up boundary wall construction immediately after award. He may also consider providing temporary fence in full or part as per site requirement. d) Proper housekeeping by systematic and proper disposal of earth from excavations (separately for usable & surplus earth), muck (from pile bores or otherwise), wastes (from dismantling of pile tops, concrete works etc.), packing & insulation wastes, steel scrap, cable wastes etc. generated during construction / erection works, Suitable disposal sites for each of above shall be identified in the layout and at site in the beginning of the project itself. It shall be ensured that all agencies engaged by the bidder follow the discipline to dispose off of earth spoils and wastes at the designated places. Preferably once in a week suitable time slot will be identified for housekeeping by all agencies and suitable instructions shall be issued in this regard. Bidder may engage a separate agency or identify a gang for collection of wastes and disposal to designated places. Suitable arrangement/tieup will also be made for periodic disposal of wastes/scrap from the designated places.		
KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 391 OF 393

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	e) All fabrication area shall be suitably hard crusted to provide a water free and proper working platforms. Suitable sheds preferably pre engineered structures to be provided for paint shops, fabrication workshops etc. for ensuring all weather work conditions for onsite structural works. For the main plant and auxiliary buildings, bidder should preferably plan the works in such a way that structural fabrication in done in suppliers' offsite works/workshops and onsite fabrication works are avoided kept minimum. f) Suitable onsite maintenance workshop for day to day breakdown maintenance heavy plant and equipment like batching plants, cranes, earth moving equipment, poclains, welding equipment etc. The workshop shall have stock of frequently needed spares and suitable repair facilities with experienced technicians/ mechanics. A central test laboratory equipped with test equipment for routine test like tests on soil, concrete, bricks, aggregates, welds etc with experienced staff shall be established at the start of the project itself. g) All office and covered store buildings of the bidder and its agencies shall be of prefab/ pre-engineered / porta cabin construction. Shabby semi-finished constructions in brickwork/ GI asbestos roof etc shall not be permitted. h) First aid facilities and amenities like rest rooms, suitable pre engineered toilets (separate for men and women), drinking water fountains/tanks, canteen, crèche for women workers shall be planned and established at the beginning of the project itself These facilities shall be located distributed over the plant area to enable easy access by the construction workers and staff and shall be marked on the plant layout. Suitable treatment for toilet discharge, like bio digesters etc. shall be planned and conventional septic tanks/ soak pits etc. shall be avoided. i) Proper lighting of all construction/ erection areas. Bidder shall erect adequate number of high lighting masts in main plant, offsite, office and store areas for lighting during night, DG sets of adequate capacity shall be provided for emergency back up. The street lighting along the roads shall also be prioritized along with road construction. The construction power ring main shall be planned and erected immediately after the award. j) Well planned and coordinated storage and movement of plant, equipment and construction materials. System wise/ agency wise storage / laydown areas shall be planned and marked on the plant layout at the beginning itself. Bidder shall ensure that all its agencies comply to the areas allocated to them and follow the designated storage and movement plans. Adequate covered storage shall be constructed for storage of critical equipments like switchgears, MCCs, insulation etc. k) Proper access control for construction workers, staff and visitors. Bidder shall ensure that suitable electronic based gate pass system is in place from start of project itself to keep record and track of all workers, staff and visitors entering / exiting the plant premises shiftwise on daily basis. l) Compliance to all safety requirements as specified elsewhere in the tender documents. Bidders shall establish a safety centre at the start of the project itself. It shall have a 24X7 manned safety control room in addition to a permanent safety equipment display room, separate training / lecture hall with AV facilities for safety training, store room with adequate stock of specified safety equipment, a first aid room and other amenities. Bidder shall install CCTV cameras at all strategic locations in the plant area which shall be linked to the safety control room.			
KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 392 OF 393	

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	m) Compliance to all environment and other conditions stipulated by the concerned statutory authorities while according clearance / NOC to the project. Bidder shall ensure adequate sprinkling of water by deploying water tankers to prevent the fugitive dust nuisance during construction. n) Development of suitable landscape & green belt areas and rainwater harvesting within the plant premises. Bidder shall plan to develop the landscape & green belt areas and rainwater harvesting from the start of the project itself. The landscape and rainwater harvesting plan shall be finalized immediately after award of work and suitable work plan with priority and schedule shall also be finalized thereafter. Top soil before excavation shall be suitably preserved and stacked for landscape and green belt development. o) Provision of adequate shelters, water supply, sanitation and lighting in construction workers and staff camps. No camps for workers and staff shall be permitted within the plant premises and Bidder shall make separate arrangement outside the plant premises for locating and development of camps for construction workers and staff. The designated areas shall be suitably developed with infrastructure like roads, drains, water supply and sewerage and shall be free from water logging. Suitable low cost shelters will be provided for the workers. Complete area shall be secured by fencing and shall be provided adequate area lighting. Suitable waste disposal, shopping and recreation facilities will be developed in these camps. Bidder shall ensure that due importance is given to site management as discussed above and a detailed work plan considering the above aspects is finalized immediately after the award. A senior level executive shall be identified who shall be responsible for implementation of the work plan. Suitable format for progress reporting on site management plan shall be developed and made part of the project progress report. The progress on implementation of above work plan shall be reviewed along with project progress in the monthly project review meetings with owner. In case the progress in the monthly project review meetings with owner. In case the progress on site management plan is unsatisfactory Engineer-in-Charge may withhold upto 1% of the monthly running bill (for civil and site erection works) till such time the required progress is demonstrated. In case in the opinion of Engineer- in-charge bidder's response is not adequate despite reminders and the situation warrants immediate action, Engineer-in- charge may get the relevant work executed through a separate agency and deduct the expenses incurred from the Bidder's bill along with overheads @25%.		
KHARGONE STPP (2X660MW) EPC PACKAGE	TECHNICAL SPECIFICATION	SUB-SECTION- CIVIL WORKS	PAGE 393 OF 393



**TITLE: - 2X660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION : D

REV.NO. 00

SHEET

SECTION D

TECHNICAL SPECIFICATION(S)



**TITLE: - 2X660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

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**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

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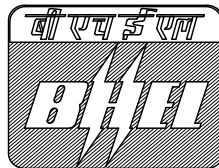
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

EARTHWORK IN EXCAVATION AND BACKFILLING



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001			
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**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
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SPECIFICATION NO. PE-TS-K13-600-C001

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**TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.0.0 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.

2.0.0 GENERAL

2.1.0 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.

2.2.0 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.

2.3.0 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

	TITLE: - 2x660 MW KHARGONE STPP. TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING	SPECIFICATION NO. PE-TS-K13-600-C001																				
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of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :- <table><tr><td>IS:1200 (Part-I)</td><td>Method of Measurement of Building and Civil Engineering work; Part - I Earthwork.</td></tr><tr><td>IS:2720 (Part-II)</td><td>Determination of Moisture Content</td></tr><tr><td>IS:2720 (Part-VII)</td><td>Determination of Moisture content / Dry Relation using Light Compaction.</td></tr><tr><td>IS:2720 (Part-xiv)</td><td>Determination of Density Index (Relative Density) of cohesionless soils.</td></tr><tr><td>IS:2720 (Part-xxix)</td><td>Determination of Dry Density , in place, by core cutter method.</td></tr><tr><td>IS:2720 (Part- xxviii)</td><td>Determination of Dry Density of soils, in place, by sand replacement methods.</td></tr><tr><td>IS:3764</td><td>Safety code for Excavation work.</td></tr><tr><td>IS:4081</td><td>Blasting and Related Drilling Operations</td></tr><tr><td>IS:4701</td><td>Earthwork on canals</td></tr></table>					IS:1200 (Part-I)	Method of Measurement of Building and Civil Engineering work; Part - I Earthwork.	IS:2720 (Part-II)	Determination of Moisture Content	IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.	IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.	IS:2720 (Part-xxix)	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	IS:4701	Earthwork on canals
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IS:3764	Safety code for Excavation work.																					
IS:4081	Blasting and Related Drilling Operations																					
IS:4701	Earthwork on canals																					
2.4.0 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.																						
2.5.0 Materials to be used																						
2.5.1 General All materials required for the work shall be of best commercial variety and approved by the Engineer.																						
2.5.2 Borrow Material Borrow material required for back-filling shall be excavated from approved locations and 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.																						



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

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2.6.0 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.
- b) Back-filling :
- i) Checking the quality of fill material
 - ii) Checking moisture content of the backfill
 - iii) Checking the degree of compaction

2.7.0 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 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.

3.0.0 EXECUTION

3.1.0 Setting Out

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, in case any errors are noticed in the Contractor's work at any stage.



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3.2.0 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 therefrom, 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.

3.3.0 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 levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150 mm 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 250 mm 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 burnt 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.

3.4.0 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



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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 ;



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ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

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 chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 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.



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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.

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 (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 overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4. 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.

**3.5.2 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.

3.5.3 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. 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



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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 chiselling, wedging or any other approved method.

3.5.4 Blasting

3.5.4.1 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.

3.5.4.2 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 mezzanine 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.



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Magazine shoes without nails shall be used while entering the magazine.

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 duststorm 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.

3.5.4.3 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.

3.5.4.4 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 shotfirer. Wrappings shall never be removed from explosive cartridges. Only



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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 shotfiring 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 shotholes, 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 shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer 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 shotfirer 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 shotfirer 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 at least half an hour after firing.

When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shotholes and filling the same with light charge of explosives.



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Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.5 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.

3.5.6 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.

3.5.7 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.

3.5.8 Dealing with Surface Water



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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 to drain surface water from working areas.

3.5.9 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 and 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 dewatering 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.

3.5.10 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.

3.5.10.1 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 250 x 40 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 ballies 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

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	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 proceeded 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. 3.5.10.2 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. 3.6.0 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. 3.7.0 Back-filling 3.7.1 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. 3.7.2 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 than																



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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 mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled 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.

3.7.3 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.

3.7.4 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.



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3.7.5 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.

3.8.0 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.

3.9.0 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.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 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. 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 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.

4.2.0 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

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	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. 5.0.0 INFORMATION TO BE SUBMITTED 5.1.0 With Tender Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender. 5.2.0 After Award After award of the Contract the successful tenderer shall submit the following for approval and adoption : a) 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. The programme should 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) The Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.																



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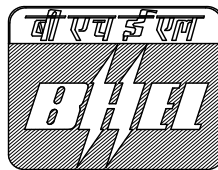
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



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**TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**

1.0 SCOPE

1.1 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.

1.2 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.

1.3 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.

2.0 GENERAL

2.1 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



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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 and specifications.
- 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.

2.2 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.

2.3 Information to be submitted by the Tenderer

2.3.1 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.



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d) Types of formwork proposed to be used.

2.3.2

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**

The Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials for the procurement.

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.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

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 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**



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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.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(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 2.1 (c).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.1 (e).

g) Mill Test Reports for Cement & Reinforcing Steel

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 2.4 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.

2.4

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



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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.

2.5 Materials to be used

2.5.1 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.

2.5.2 Cement

Generally cement shall be 33 grade ordinary Portland Cement conforming to IS-269 . 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) 43 Grade ordinary Portland Cement conforming to IS-8112
- b) 53 Grade ordinary Portland Cement conforming to IS-12269
- c) Rapid hardening Portland Cement conforming to IS-8041
- d) Portland slag cement conforming to IS-455
- e) Portland Pozzolona Cement (flyash based) Conforming to IS- 1489 (Part -1)
- f) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)
- g) Hydrophobic Cement conforming to IS-8043
- h) Low heat Portland Cement conforming to IS : 12600
- i) Sulphate Resisting Portland Cement conforming to IS-12330

2.5.3 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



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Aggregate of sizes ranging between 4.75 mm and 150 mm 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.

2.5.4 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-1 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.

2.5.5 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



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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" .

b) Retarding admixtures :

- Modified ligno sulphonate based set retarding concrete admixture like , "Plastiment R".

c) Water reducing admixtures :

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" .

d) Air entraining admixtures :

- Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER".

e) **Water proofing admixtures**

- Modified ligno-sulphonate based waterproofing admixture like "Plastocrete Super".

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 :

- Type of admixture
- Mix proportion & mode of application in concrete/mortar
- Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content , PH value infra red analysis & solid content.)

2.5.6 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.



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2.6.0 Storage of Materials

2.6.1 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 Storage of materials shall conform to IS:4082.

2.6.2 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 and different types of cement shall not be intermixed.

2.6.3 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.

2.6.4 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. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.7 Quality Control



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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 and 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 plices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or certificates to satisfy relevant IS Specification (If Contractor's supply).

g) Grades of concrete : Usage and 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.



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k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and 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 and 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.

3.0 **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.

3.1 **Washing and Screening of Aggregates**

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt 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.



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However , all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.2

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.

3.3

Grades of Concrete

Structural concrete shall be of M30 grade and for other part of the work shall be as shown on the drawing as per grade classification of IS-456. In case of liquid retaining structures, IS:3370 will be followed.

3.4

Proportioning and Works Control

3.4.1

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.

3.4.2

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 :



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- 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, values given in the tables in IS:456, shall be followed.

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.



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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.

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 OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0



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Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

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 for 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.

3.5 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.

3.6 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per Table-5 of IS : 456.

3.7 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on -

- The requirement of strength.
- The requirement of durability.

3.7.1 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.



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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, proportions for different grades of concrete is specified in Table-9 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.7.2

Durability Requirement

Table-5 of IS:456 gives 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.

In general the water cement ratio between 0.4 and 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.

3.8

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 :



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TABLE - III
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 equipment, 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. 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.

3.9

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 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Mass concrete in very large structure	- 150 mm



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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

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 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.

Ingradients for design mix concrete shall be measured by wieght. For small jobs portable swing weigh Bachers 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



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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.

3.11

Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying 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

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



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- 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.

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,



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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 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.

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 Construction Joints and Cold Joints

3.13.1 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and 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



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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 sub-mitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.2 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 systemetically 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



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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 clause 3.12.

3.14 Repairs, Finishes and Treatment of Concrete surfaces

3.14.1 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. 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. 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 inforcement.
- 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 bycutting out defective concrete.
- i) Groting with a cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortar.



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- k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.2 Finishing Unformed Surface

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 over-trowelling, 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 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 Protection and Curing of concrete



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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)" 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.

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 entirely at the discretion of the Engineer.

3.16

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



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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.

3.16.1 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.

3.16.2 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.3 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°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.

3.16.4 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



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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.

3.16.5 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.

3.16.6 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 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).



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3.18 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 precooling, postcooling or any other method, if required, will be specified.

3.19 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 Form Work

3.20.1 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. Reckers 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



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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 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, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. 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.

3.20.2

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/ Siparol Concentrate" 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.

3.20.3

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



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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 pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.4 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.

3.20.5 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 manner, 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. 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.



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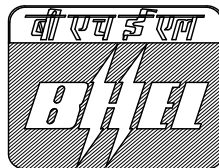
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GENERAL TECHNICAL SPECIFICATION

FORMWORK



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Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



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TABLE - IV

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.C	40 Deg.- 20 Deg.	20 Deg.- 5 Deg.	Below 5 Deg.	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.- 5 Deg.	Below 5 Deg.
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

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 of 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



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the time of removal of form as mentioned above . This has to be supported by regular tests.

3.20.6

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 - ± 5 mm
- b) Plumb - 1 in 1000 of height
- c) Levels - ± 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.

3.20.7

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 hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.8

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-use may only be permitted after special inspection and approval



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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 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** 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. 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. 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 Expansion and Isolation Joints



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3.23.1

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. 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.

3.23.2

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/lof 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.

3.23.3

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.



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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 vulcanised.

Non - metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. 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 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



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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%

3.23.4 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.

3.23.5 Isolation Joints



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Strong and tough alkathene or PVC sheet 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.

3.23.6 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 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-shrink, 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 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 levelled 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



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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, 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 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 Waterproofing of Concrete Structure

3.26.1 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" 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.



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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. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.2

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.

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



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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.

3.26.3

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, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/ Cm.m a melamine based super plasticizer will be preferable.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. 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 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 like "Noleak CP/Sika Latex" or approved equivalent 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. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.



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3.26.4

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.

3.26.5

Protective Coating on Inside Surface

Two coats of 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.

3.26.6

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.

The Contractor shall execute this work in direct collaboration with one of the well known specialised 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.

3.26.7

Polyethelene Films : Application in Walls or base of Structures



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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 polyethelene 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 polyethelene 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 celophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another celophane 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 celophane 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 bitument 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethelene 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-100, 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 Protective coating on Concrete Surface

3.27.1 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 bitumen emulsion protective coating of approved manufacturer.



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3.28

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.

4.0

SAMPLING AND TESTING

4.1

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.

4.2

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. 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.

4.3

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.

4.4

Water



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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.

4.5 Admixture

4.5.1 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 by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.5.2 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.

4.6 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 14 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 15 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



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embedded items or adjacent structures, the same shall be made good to the satisfaction of the Engineer.

5.0 ACCEPTANCE CRITERIA

5.1 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS:456.

5.2 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.3 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.

5.4 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. 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.

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 by the Contractor to the satisfaction of the Engineer.



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6.0

LIST OF I.S. 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



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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



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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 - art - 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 Danp 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 Archs
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete



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IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
IS : 4995	-	Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
IS : 4998	-	Indian Standard Specification for Design of (Part - I) Reinforced Concrete Chimneys
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS : 5513	-	Indian Standard Specification for Vicat Apparatus
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use
IS : 6909	-	Indian Standard Specification for Supersulphated Cement
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
IS : 7242	-	Indian Standard Specification for Concrete Spreaders
IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete
IS : 7251	-	Indian Standard Specification for Concrete Finishers
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus



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IS : 7861	-	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement
IS : 8043	-	Indian standard specification for hydrophobic cement
IS : 8112	-	Indian Standard Specification for 43 grade Ordinary Portland Cement
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS : 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction
IS : 10262	-	Recommended Guideline for concrete Mix Design
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement
IS : 12330	-	Indian standard specification for sulphate resisting portland cement
IS : 12600	-	Indian standard specification for low heat portland cement



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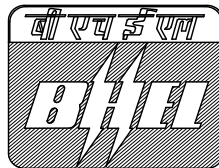
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GENERAL TECHNICAL SPECIFICATION

FABRICATION OF STRUCTURAL STEELWORK



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**

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**TECHNICAL SPECIFICATION
FOR
FABRICATION OF STRUCTURAL STEELWORK**

1.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on contractor's design drawings approved by the Owner / Consultants.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be in adequate quantity to avoid delay in erection.
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items



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required in connection with the fabrication and erection of the structural steelwork.

- h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.2.0 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.3.0 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of 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 the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

**LIST OF I.S. CODES - RELEVANT TO FABRICATION OF
STRUCTURAL STEEL WORK**

IS Codes

Description

IS : 800	-	Code of practice for general construction in steel.
IS : 801	-	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806	-	Code of practice for use of steel tubes in general building construction.
IS : 808	-	Dimensions for rolled steel beams, channels and angle sections.
IS : 812	-	Glossary of terms relating to welding & cutting of metals.
IS : 813	-	Scheme of symbols for welding.
IS : 814	-	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.



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IS : 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS : 817	-	Code of practice for training & testing metal arc welders.
IS : 818	-	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS : 819	-	Code of practice for resistance spot welding for light assemblies in mild steel.
IS : 822	-	Code of practice for inspection of welds.
IS : 919 (Part - 1&2)	-	Recommendations for limits and fits for engineering.
IS : 1161	-	Steel Tubes for structural purposes.
IS : 1182	-	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work
IS : 1239 (Part - 1&2)	-	Mild steel tubes, tubulars and other wrought steel fittings
IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws and nuts of product grade C.
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A & B.
IS : 1365	-	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.
IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.



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- IS : 1852 - Rolling and cutting tolerances for hot-rolled steel product.
- IS : 1977 - Structural steel (Ordinary quality)
- IS : 2016 - Plain washer
- IS : 2062 - Steel for general structural purposes.
- IS : 2629 - Recommended practice for hot-dip galvanising of iron and steel.
- IS : 2633 - Method for testing uniformity of coating on zinc coated articles.
- IS : 3644 - Code of practice for ultrasonic pulse echo testing by contact and immersion method.
- IS : 3757 - High Strength Structural Bolt
- IS : 4000 - High strength bolts in steel structure
- IS : 4759 - Specifications for hot-dip zinc coatings on structural steel and other allied products.
- IS : 4923 - Hollow steel sections for structural use.
- IS : 5334 - Code of practice for magnetic particle flaw detection of weld.
- IS : 5369 - General requirements for plain washers and lock washer.
- IS : 6005 - Code of practice for phosphating of iron and steel.
- IS : 6649 - Specification for hardened and tempered washers for high strength structural bolts and nuts.
- IS : 6623 - Specification for high strength structural nuts.
- IS : 7215 - Tolerances for fabrication of steel structures.
- IS : 7280 - Bare wire electrode for submerged arc welding.
- IS : 8500 - Structural steel micro alloyed (medium & high strength quality).
- IS : 8629 - Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
- IS : 9595 - Recommendation for metal arc welding of carbon manganese steels.

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- IS : 117 - Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
- IS : 128 - Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
- IS : 1477 - Code of practice for painting of ferrons metal
(Part - I & II) in building.
- IS : 2074 - Ready mixed paint, air-drying red-oxide zinc chrome priming.
- IS : 2339 - Specification for aluminium paints for general purposes in dual container.
- IS : 2932 - Specification for enamel, synthetic exterior type - I.
- IS : 2933 - Specification for enamel, synthetic exterior type - II.

2.4.0 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.5.0 Materials to be used

2.5.1 General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each



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container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.5.2

Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

- 1) IS : 801 - Cold formed light gauge steel structural member.
- 2) IS : 806 - Steel tubes in general building construction.
- 3) IS : 1161 - Steel tubes for structural purpose.
- 4) IS : 1977 - Structural steel (Ordinary quality)
St-42-0
- 5) IS : 2062 - Steel for general structural purpose
- 6) IS : 8500 - Structural steel-microalloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.5.3

Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

- 1) IS : 814 - Covered electrodes for metal arc welding structural steel
- 2) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- 3) IS : 7280 - Base wire electrode for submerged arc welding.

2.5.4

Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

- a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less



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than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen : -

1) IS:1367 - Technical supply conditions for threaded fasteners.

2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High
Tensile
Steel :

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.5.5 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

- 1) IS : 1977 - Structural steel (Ordinary Quality) St-42-0
- 2) IS : 2062 - Steel for general structural purpose
- 3) IS : 8500 - Structural steel - microalloyed (medium & high strength quality)
- 4) IS : 6623 - High Strength Structural Nuts
- 5) IS : 6649 - Hardened and tempered washers for high strength structural bolts & nuts.

2.5.6 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimer Paints Ltd., may be necessary.

2.6.0 Storage of Material

2.6.1 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed. The Contractor shall maintain upto date



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accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.6.2 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.6.3 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.6.4 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.6.5 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.7.0 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.



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The quality control procedure shall cover but not be limited to the following items of work :

- 1) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- 2) Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.
- 3) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- 4) Welders : Qualifying Tests
- 5) Welding sets : Performance Tests
- 6) Welds : Inspection, X-ray, Ultrasonic tests
- 7) Paints : Manufacturer's certificate, physical inspection reports
- 8) Galvanizing : Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.8.0

Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.9.0

Shop Drawings

The Contractor shall submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall start to submit progressively for approval the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness



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of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :-

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolt location etc.
- c) Details of all connections with supporting calculations.
- d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.
- e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately.

Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or



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other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.0.0 WORKMANSHIP

3.1.0 Fabrication

3.1.1 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.1.2 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.1.3 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.1.4 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.



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3.1.5 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.2.0 Bolted construction

3.2.1 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.2.2 Assembly

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.



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Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.3.0 Welded Construction

3.3.1 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.3.2 Preparation of Material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.3.3 Assembling

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.3.4 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Engineer, welded



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assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.3.6

Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.3.7

Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.3.8

Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and



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capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.4.0 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.5.0 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.6.0 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

3.7.0 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.8.0 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.9.0 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.0 Shop connections

- a) All shop connections shall be welded as specified on the Drawings.
- b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes.



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3.11.0 Castings

Steel castings shall be annealed

3.12.0 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.0 Shop painting

3.13.1 General

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by thorough sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall immediately be painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy resin based zinc rich primer such as Blast Steel EZ1 of Shalimer Paint Limited.

3.13.2 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.3 Contact surfaces



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Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.4 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.5 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.0 Galvanizing

3.14.1 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.2 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.3 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.



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The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.0.0 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.1.0 Inspection

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.2.0 Testing and Acceptance Criteria



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4.2.1 General

The Contractor shall carry out 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 the Contract. 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.

4.2.2 Steel

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.2.3 Testing Criteria for checking Lamination in raw steel plates

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

- a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.
- b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item is found to be laminated, the component will be rejected.

4.2.4 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of



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further tests as may be desired by the Engineer, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken.

4.2.5 Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.2.6 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.2.7 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.3.0 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.4.0 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate,



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upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.5.0 Delivery of materials

4.5.1 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.5.2 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.5.3 Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following : -

a) Name and address of the consignee



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- b) Name and address of the consignor
- c) Gross weight of the package in tonnes and its dimensions
- d) Identification marks and/or number of the package
- e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially :

- a) Name of the Contractor
- b) Number and date of the Contract
- c) Name of the office placing the contract
- d) Nomenclature of stores
- e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.



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Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

The following information are required to be submitted with the Tender :

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

- 1) Preparation and approval of shop drawings
- 2) Procurement of materials
- 3) Fabrication and shipping of all anchor bolts
- 4) Fabrication and shipping of main steelwork
- 5) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.
- 6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork
- 7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

c) Matching Steel

A rough indication of the quantities and details of matching steel sections required to start the work shall be furnished.



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5.2.0

After Award

After award of the Contract the successful Tenderer is to submit the following :

- a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the upto date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Results of any test as and when conducted and as required by the Engineer.
- d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.



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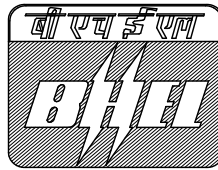
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GENERAL TECHNICAL SPECIFICATION

ERECTION OF STRUCTURAL STEELWORK



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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**FOR
ERECTION OF STRUCTURAL STEELWORK**

1.0.0 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:-

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures if required by the Contract.
- g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following :



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- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
- ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
- iii) Reaming of holes for use of higher size bolt if required.
- iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.
- v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.
- vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- viii) Carry out tests in accordance with this Specification if directed.

2.2.0 Work by others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3.0 Codes and Standards

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 Specification and codes of Practice of equivalent:-

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.4.0 Conformity with designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard



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Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Engineer.

2.5.0 Material

2.5.1 General

The Contractor will check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The Contractor shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Engineer.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.5.2 Materials to conform to Indian Standards

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.6.0 Storage of materials

2.6.1 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency.

2.6.2 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work. The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor as directed by the Engineer.

2.6.3 Covered Store



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All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built.

2.7.0 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:-

- 1) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- 2) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.
- 3) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The Contractor shall salvage, collect and deliver all the packing materials to the Owner.

3.0.0 WORKMANSHIP

3.1.0 Erection

3.1.1 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.1.2 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.1.3 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.



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If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

3.1.4 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.1.5 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.1.6 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.



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All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8x dia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.



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TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.1.7

Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.1.8

Holes, cutting and fitting



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No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.2.0 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.3.0 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementitious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.



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3.4.0 Painting after erection

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.5.0 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing.

The stainless steel liner shall be fixed to the Bunker hopper by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16 ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways. The plug welding shall be ground flush with the lining plate.

3.6.0 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove all falsework, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.7.0 Safety Measures during Erection



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The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Contractor responsible, to the satisfaction of the Engineer.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.1.1 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.1.2 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both



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conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.1.4 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. hereinbefore.

4.2.0 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below :

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
Main columns	a) Shifting of column axis at foundation level with respect to building line	



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i) In longitudinal direction	i) ± 3.0 mm
ii) In lateral direction	ii) ± 3.0 mm
b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10M length measured between connection levels, but not more than ± 7.0 mm per 30 m length.

Component

Description

Variation Allowed

c) For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm

Trusses

a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or not greater than 10 mm whichever is the least.



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Crane
Girders &
Tracks

b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports. 1/250 of depth of truss or 20 mm whichever is the least.

a) Difference in levels of crane rail measured between adjacent columns. 2.0 mm

b) Deviation to crane rail gauge ± 3.0 mm

c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding. 1.0 mm

d) Deviation of crane rail axis from centre line of web. ± 3.5 mm

Component

Description

**Variation
Allowed**

Setting of
Expansion
gaps

At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.3.0

Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or



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otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 Before Tender

Along with the Tenders the Tenderers will be required to submit the following information :

5.1.1 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

**5.1.2 Constructional Plant and Equipment, Tools,
Temporary Works & Manpower**

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.1.3 Erection yard

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.2.0 After award of the Contract

After award of the contract, the Contractor shall submit the following :-

5.2.1 Detailed Programme

The Contractor shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of



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required strength of various categories of workers in a proforma approved by the Engineer.

5.2.2

Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.



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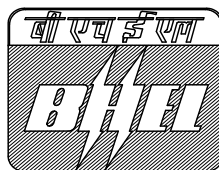
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GENERAL TECHNICAL SPECIFICATION

ROAD AND DRAINAGE



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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General Standard Technical Specification For Road And Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.
- b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.
- c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used



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All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

- a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC
- b) IRC: 19 - Standard specification and code of practice for Water bound Macadam
- c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways
- d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
- e) IS:2212 - Code of Practice for Brick work
- f) IS: 783 - Code of Practice for Laying of Concrete Pipes
- g) IS: 1201 - Methods of testing tar and bituminous materials to 1220
- h) IS: 73 - Specification for paving bitumen
- i) IS: 215 - Specification for Road tar
- j) IS: 216 - Coal tar pitch
- k) IS: 217 - Specification for cut-back bitumen
- l) IS: 454 - Specification for cut-back bitumen from waxy crude
- m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete
- n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre



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Part II CNSL Aldehyde resin and coconut pith

- o) IS : 334 - Glossary of terms relating to bitumen and tar
- p) IS: 1077 - Common burnt clay building bricks
- q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)
- r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements
- s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm 25\text{mm}$ therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be $\pm 40\text{mm}$.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	$\pm 25\text{ mm}$
Sub-base	$\pm 20\text{ mm}$
Base course	$\pm 15\text{ mm}$



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Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8



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6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall 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 checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing



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Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.



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Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.



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3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under



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construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06

Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.



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Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as



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shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

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3.04.04

Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05

Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06

Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00

Shoulder Construction

3.05.01

Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02

Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03

Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside

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edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00

Kerb

3.06.01

Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02

Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00

Sub-base (Granular Sub-base)

3.07.01

Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02

Materials



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The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

**Table - IV
Grading for Granular Sub-base Material**

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of



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loose layers shall be so regulated that the maximum thickness of each layer layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements



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Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value b) Flakiness Index ***	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 ** IS : 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates



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The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

**Table - VI
Grading Requirements of Coarse Aggregates**

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.



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**Table - VII
Grading For Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03

Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading



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shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not



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be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled

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with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.				
3.09.00	Tack Coat			
3.09.01	Description			
The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.				
3.09.02	Materials			
The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.				
3.09.03	Construction Operations			
a) Preparation of Base				
The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.				
b) Application of Binder				
Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.				
3.10.00	Bituminous Macadam Binder Course			
3.10.01	Description			
This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in				



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accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

**Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam**

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.



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**Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous
Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

**Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials



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The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03

Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit



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manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

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Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C. Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it. The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it. 3.11.00 Open Graded Premix Carpet 3.11.01 Description This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification. 3.11.02 Materials a) Binder The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable. b) Aggregates The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30. c) Proportioning of Materials The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet. Table - XI		



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**Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick
Open Graded Premix Carpet**

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
Total		0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0.18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
Total		14.6 Kg

3.11.03

Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat



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A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be



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painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.



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c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03

Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable



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design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments



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as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the “Specification for Earthwork in Excavation and Backfilling”, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer’s specification. The tenderer shall specifically mention the particular manufacturer’s product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.



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Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per “Specification for Earthwork in Excavation and Backfilling” to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the “Specification for Earthwork in Excavation and Backfilling”. When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

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e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03

Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00

Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00

Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00

MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.



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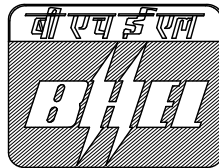
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SECTION - D
GENERAL TECHNICAL SPECIFICATION
MASONRY & ALLIED WORKS



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



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**TECHNICAL SPECIFICATION
FOR
MASONRY & ALLIED WORKS**

1.0.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.0.0 INSTALLATION

2.1.0 Soling

2.1.1 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.1.2 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling as shown as the drawings. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.2.0 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.



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2.3.0 Masonry

2.3.1 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.3.2 Mortar

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form a putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a water-tight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement. No mortar which has stood for more than half an hour shall be used.

2.3.3 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.



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2.3.4 Exposed Brickwork

Brickwork in superstructures which is not covered by plaster shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brick-work shall be cleaned at the end of days work. If face bricks are specified in the drawings, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.3.5 Reinforced Brickworks

Reinforcements shall be as specified in the drawings. All reinforcements shall be thoroughly cleaned and fully embeded in mortar. Where M.S. bars are used as reinforcement, these shall be laped with dowels if left in R.C. columns or welded to steel stanchions.

2.3.6 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

2.3.7 Exposed Stonework

Stonework which is to be kept exposed shall be as shown on drawing or described in the Schedule of Items. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 sq.m. in area shall be built and approved by the Engineer and all works shall match with this sample.

2.3.8 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.



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2.3.9 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.3.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.3.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.3.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.3.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

2.4.0 Damp Proof Course

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.5.0 Damp Proof Membrane



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Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS:1609. The number of courses shall be as mentioned. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.0.0

I.S. CODES

Some of the important relevant codes for this section are :

IS:1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS:1597	:	Code of Practice for Construction of stone Masonry.
IS:1609	:	Code of Practice for laying Damp-proof treatment using bitumen felts.
IS:2212	:	Code of Practice for Brickwork.
IS:2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS:5134	:	Bitumen Impregnated Paper & Board.



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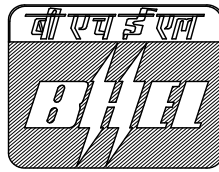
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

FINISH TO MASONRY & CONCRETE



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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**TECHNICAL SPECIFICATION
FOR
FINISH TO MASONRY & CONCRETE**

1.0.0 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment. Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimise damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.0.0 INSTALLATION

2.1.0 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval or the Engineer shall be taken as to the acceptability of the base.

2.2.0 Plastering

2.2.1 Mortar

Mortar for plastering shall be as specified in the drawings.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.



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For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster which has stood for more than half an hour shall be used; plaster that shows tendency to become dry before this time, shall have water added to it.

2.2.2

Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat, the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.2.3

Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be



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finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.2.2 but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the top coat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS:2114 latest edition. Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.2.2. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-Cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.2.2 after being levelled and allowed to stiffen for a few hours, shall be scraped



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with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2. Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

2.2.4 Curing

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.3.0 Pointing to Masonry

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.4.0 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers.

The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.2.1. The application, finish etc. shall be as specified under relevant clause above. A 2 mm Plaster of Paris punning



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shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.5.0 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.6.0 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.7.0 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.



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Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.0.0

ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as shown on drawings.

4.0.0

I.S. CODES

Important relevant code for this Section :

- a) IS:1661 : Code of practice for cement and cement-lime plaster finish on walls & ceilings.
- b) IS:4101 : Code of practice for external facings and veneers.



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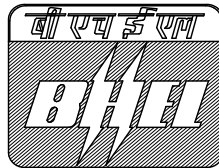
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

FLOOR FINISHES AND ALLIED WORKS



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
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**TECHNICAL SPECIFICATION
FOR
FLOOR FINISHES AND ALLIED WORKS**

1.0.0 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below :

a) In Situ Finishes

- i) Integral finish to concrete base
- ii) Red Oxide of Iron finish
- iii) Terrazzo finish
- iv) Granolithic finish
- v) Patent Stone
- vi) Metallic Hardener like "Ironite" finish
- vii) Mastic Asphalt finish
- viii) Chemical Resistant finish

b) Tiled Finishes

- i) Terrazzo tile
- ii) Chequered tile
- iii) Glazed tile
- iv) Tesse rae (Mosaic etc.)
- v) Chemical Resistant
- vi) Rubber, Vinyl etc.
- vii) Stone Slab

1.0.1 Base

The base to receive the finish is covered under other relevant specifications.

1.0.2 Sequence



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Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.0.0 INSTALLATION

2.0.1 Special Materials

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.0.2 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.0.3 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.



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The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.1.0 In Situ Finishes

2.1.1 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations.

This finish shall be as thin as possible by using 2.2 kg. of cement per Sq. M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.1.2 Red Oxide of iron Finish

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume.



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For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) Topping

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) Laying

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 Kg. of the mixture shall be consumed/per Sq.M. for horizontal surface, and 1.0 Kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.1.3

Terrazo Finish : In Situ



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It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.1/2 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1.1/2 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. : 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.



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c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 sq.m in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polishing

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final



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polishing shall be positioned till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M, water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.1.4

Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) **Thickness**

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) **Mix**

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) **Laying of Monolithic Topping**

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall be roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern.

d) **Laying of Topping Separately on Hardened Base**

The base concrete shall be prepared as stated in clause 2.0.3 and a slurry of neat cement applied just prior to laying the granolithic



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concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.1.3 (c) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified. The concentration and method of application of the solutions shall be as specified in IS : 5491.

2.1.5

Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) **Thickness**

The patent stone finish shall have thickness as stipulated under clause 2.1.2 (a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.1.3(b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.



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The maximum area of each panel shall be 3 Sq.M of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond.

The topping shall trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.1.6 Metallic Hardener Like "Ironite" Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish.

The surface shall be roughened by wire brush as soon as possible.



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The finish shall be laid while the concrete underbed is still very "green" within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished \smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.1.7

Mastic Asphalt Finish

This is a one layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing

b) Materials

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform to IS: 1195 and shall be either brought to site in blocks weighing about 25Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.



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The mastic shall be laid in suitable panels of about 15 Sq.M in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.1.8 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence.

The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.2.0 Tiled Finish

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.2.1 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo tile and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness + 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.



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The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.1.3 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.



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At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.1.3 (c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.1.3 (c) 2. Grinding shall not commence earlier than 14 days after laying of tiles.

2.2.2 Chequered Tile Finish

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.2.1 (a).

b) Tiles : Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.2.1 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) Underbed

As per clause 2.2.1 (c).

d) Laying

As per clause 2.2.1 (d).

e) Grinding and Polishing

As per clause 2.2.1 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.2.3 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.



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a) **Thickness**

The total thickness shall be between 20 mm and 25 mm including the underbed. The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) **Tiles : Glazed**

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 10 mm thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in extures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) **Mix : Underbed**

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

d) **Laying**

Same as clause 2.2.1 (d).

e) **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.2.4

Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.



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a) **Thickness**

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) **Tesserae Finish**

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) **Mix : Underbed**

Same as clause 2.2.3 (c)

d) **Laying**

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.2.3 (d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.2.5

Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.



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Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.2.3.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.2.6 Rubber, Vinyl or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be $\pm 1.5\text{mm}$.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.



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c) Mix : Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.2.7

Stone Slab Finish : Marble, Stone and Similar Fine Grained Stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs may be 25 mm, 30 mm or 40 mm thick as specified.

b) Stone Slab



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The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions.

Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) **Mix : Underbed**

Same as clause 2.2.1 (c).

d) **Laying**

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.2.1 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.2.8

**Stone Slab Finish : Sand Stone and
Similar Coarse Grained Stone Finish**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

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Generally clause 2.2.7 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiseled or fine chiseled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiseling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

3.0.0

ACCEPTANCE CRITERIA

The finish shall be checked specially for :

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.0.0

I.S. CODES

Important relevant codes for this section :

- IS : 777 : Glazed earthenware tiles
- IS : 1196 : Code of practice for laying bitumen mastic flooring
- IS : 1197 : Code of practice for laying of rubber floors
- IS : 1237 : Cement concrete flooring tiles
- IS : 1443 : Code of practice for laying and finishing of cement concrete flooring tiles
- IS : 2114 : Code of practice for laying in situ terrazzo floor



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

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- IS : 3461 : PVC asbestos floor tiles
- IS : 4860 : Specification for acid resistant bricks
- IS : 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring.
- IS : 5491 : Code of practice for laying in situ granolithic floor topping.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FALSE FLOORING**

SPECIFICATION NO. PE-TS-K13-600-C001

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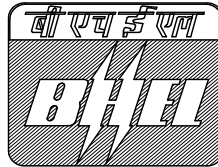
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SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

FALSE FLOORING



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FALSE FLOORING**

SPECIFICATION NO. PE-TS-K13-600-C001

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TECHNICAL SPECIFICATION FOR
FALSE FLOORING**

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**TECHNICAL SPECIFICATION
FOR
FALSE FLOORING**

1.0.0 SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

2.0.0 FALSE FLOORING SYSTEM

2.1.0 Base

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

2.2.0 Supporting Structure

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

2.3.0 Floor Panel

2.3.1 The floor panels shall be made of phenol formaldehyde bonded particle board treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm x 600 mm with all panel edges finished to a tolerance of ± 0.25 mm on the diagonals. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05 mm. thick Aluminium foil which shall be fixed to the particle board with resin-based adhesive.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FALSE FLOORING**

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2.4.0 Strength

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq.M or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

2.5.0 Surface Finish

All removable panels shall have the top surface finished with 2 mm thick Antistatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

2.6.0 Skirting

Skirting shall be of the same Antistatic Vinyltiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

2.7.0 Installation

All steel surface are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without to the owner.

3.0.0 ACCEPTANCE CRITERIA

The false flooring system shall be checked specially for :

- a) Level
- b) Alignment of joints
- c) Thickness of joints
- d) Surface finish
- e) Colour and texture



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CARPENTRY AND JOINERY**

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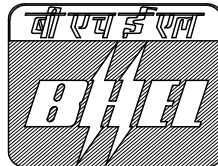
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SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

CARPENTRY & JOINERY



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CARPENTRY AND JOINERY**

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**TECHNICAL SPECIFICATION
FOR
CARPENTRY & JOINERY**

1.0 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate. This shall also include the supply and fixing of all hardware and fixtures shown in drawing.

2.0 INSTALLATION

2.1 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenters work, the Tenderer shall have the rough timber approved by the Engineer.

b) Plywood

Plywood shall be commercial quality with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol-formaldehyde resin of B W R grade conforming to IS:848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number of joints in one surface.

d) Flush Doors

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CARPENTRY AND JOINERY**

SPECIFICATION NO. PE-TS-K13-600-C001

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The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of B W R grade, conforming to IS:848. The thickness shall be as specified in the drawing.

e) Panel Doors

Panel door shall be of teakwood shutter frame and panels of teakwood. Other considerations shall be as mentioned in item (d) above.

f) Fixtures

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing.

2.2 Workmanship

2.2.1 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blockboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M S grills or guard bars shall be provided to windows where called for in the drawings.

2.2.2 Finish



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CARPENTRY AND JOINERY**

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All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

2.2.3 Surface Treatment

When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

3.0 ACCEPTANCE CRITERIA

3.1 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.2 Door and Window Shutters

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.3 Partitions, Paneling, Pelmet, Furniture, etc.

3.3.1 General

These shall conform to drawings in all details. No unsightly nailmarks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CARPENTRY AND JOINERY**

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3.3.2 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.3.3 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.3.4 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.3.5 Drawers

Shall operate smoothly and have back stops to prevent them from being pushed too far. Locks shall engage securely.

3.3.6 Loose Furniture

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.0 I.S. CODES

Some of the important relevant Codes for the Section are:

IS:4021 - Timber door, window and ventilator frames.

IS: 1003 - Timber paneled and glazed shutters.

IS:2191 - Wooden flush door shutter (Cellular and hollow core type).

IS:2202 - Wooden flush door shutters (solid core type).



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-K13-600-C001

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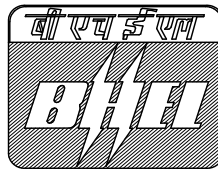
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

SUSPENDED CEILING



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

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**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
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**TECHNICAL SPECIFICATION
FOR
SUSPENDED CEILING**

1.0.0 SCOPE

This specification covers the furnishing of all materials, labour, tools, equipment, supervision and services necessary for incidental to the supply, installation, finishing and completion of suspended ceiling work of various profiles and at all elevations as per drawing, specification and instruction of Architect/Owner. The work shall also include providing openings in the ceiling for lighting fixtures, air conditioning diffusers etc. as shown in drawing and instruction of Architect/Engineer.

2.0.0 MATERIAL

2.1.0 Aluminium Grid suspension system

- a) Suspenders : shall be fabricated from 10 dia. M.S. rod angle, flat or as required to suit ceiling profile and suspension system with turnbuckle for adjustment of levels. All M.S. works shall have one coat of synthetic enamel paint over a coat of red lead primer.
- b) Frame work/grid : shall be of aluminium sections as follows :
 - Wall angle - 25 x 25 x 1.6 mm. thick.
 - Main Tee - 35 x 25 x 1.6 mm. thick
 - Cross Tee - 25 x 25 x 1.6 mm. thick
 - Tees shall be jointed with adequate cleats etc.

2.2.0 Ceiling Panel

Ceiling Panels shall be best quality both side laminated rigid phenolic foam insulation board similar to "PHENOTHERM" as manufactured by 'Bakelite Hylam'. The thickness, size and finish shall be as per drawing.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

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3.0.0 INSTALLATION

3.1.0 The ceiling grid shall be suspended from structural walls slabs, beams truss structural steel etc. with suspender fabricated from M.S.rod/ angles/flasts etc. to the required level. The entire suspension system shall be of sufficient strength and rigidity to allow placing of planks over the grid for movement of maintenance personnel to attend various electrical and air conditioning installation over the ceiling and to carry ceiling panels in true level and plane without exceeding a deflecting of 1/360th of their span. All ceiling panels shall be secured in position using hold down clips of sufficient number. All joints in ceiling panels shall run straight.

The installation of ceiling system shall be strictly as per drawing.

4.0.0 SHOP DRAWINGS

4.1.0 Contractor shall prepare complete working details layout based on the conceptual layout and design of suspended ceiling and illumination and air conditioning layout shown on the drawings and obtain approval from the Architect/Owner before installation.

5.0.0 WORKMANSHIP

5.1.0 Shall be done in the best workmanlike manner by the manufacturer authorised agency in accordance with manufacturer standards and recommendations.

6.0.0 SAMPLES

6.1.0 3 (three) mock-up samples of reasonable size showing standard grid with panels and suspender etc. having desired finish, colour etc. shall be submitted to the Architect/Owner for approval before materials are Delivered at site. Installed material shall match approved samples.

7.0.0 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

8.0.0 I.S. CODES

IS:2441 : Code of Practice for fixing ceiling coverings.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
ORS,LOUVERS ETC**

SPECIFICATION NO. PE-TS-K13-600-C001		
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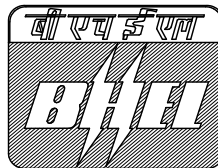
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SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

**METAL DOORS, WINDOWS, VENTILATORS,
LOUVERS, ETC.**



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
ORS,LOUVERS ETC**

SPECIFICATION NO. PE-TS-K13-600-C001			
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**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
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**TECHNICAL SPECIFICATION
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, ETC.**

1.0.0 SCOPE

The work in general shall consist of supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. The scope of work shall also include the assembly and erection of all doors, windows, louvres, glazed partitions, etc. for which fabricated materials shall be supplied by the Owner from the store at site. Supplying and/or fixing of all door and window accessories and hardware is also included in the scope.

2.0.0 INSTALLATION

2.1.0 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS:1038 and IS:1361 or as specified in drawing and schedules.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:1948 and 1949 or as manufactured by Indian Aluminium Company Limited. The alloy used shall conform to IS Designation HE 9-WP of IS:733.

Hardware and fixtures shall be as specified in "Schedule of Fixtures" and the best quality from approved manufacturers shall only be used. The Tenderer shall specifically state the particular manufacturer's materials he proposes to use. "Schedule of Fixtures" is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS:3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated in schedule. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced.

Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements and endurance test stated in IS:3564 - Appendix A.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
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The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS:1081 and/or as approved by the Engineer.

2.2.0 Fabrication

2.2.1 Steel Doors, Windows, Ventilators, Louvres etc.

a) Door Frames

Frames shall be fabricated from 16 g sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm. thick, completely flush design and shall comprise of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown on drawing, provision shall be made for fixing glazing, vision panels, louvres etc. glazing moldings shall be of 18 G steel or extruded aluminium sections with profiles shown on drawing and suitable for fixing 6 mm. glass. Louvres blades shall be V or Z shaped and made out of 16 G sheets.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
ORS,LOUVERS ETC**

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c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvres etc. shall be made.

The manufacturing shall be done as specified in 2.2.1.b. "Double Plate Flush Door Shutters".

d) Sliding Doors

Sliding doors shall be either double plate or single plate construction as called for in drawings made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings ,the Contractor shall make provision for openings to the door for mono-rail beams. Doors shall close positively to exclude rain water from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Fire resistant door

Fire proof door shall conform to I.S.3614(part I & II) and shall have fire rating as indicated elsewhere and where TAC approval will be required fire door shall also conform to TAC regulations

Door shall be double or single leaf and shall of fully metal insulated box section frame and fully insulated shutter faced with steel sheet on both faces . door shall be procured from manufacturer specialised in fire door manufacturing.

f) Door Threshold

Door threshold shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

g) Steel Windows, Sashes, Ventilators etc.

These shall conform in all respects to IS:1038 and IS:1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings.

All welds shall be dressed flush on all exposed and contact surfaces.



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TECHNICAL SPECIFICATION FOR
METALDOORS,WINDOWS,VENTILAT
ORS,LOUVERS ETC**

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Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed, fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.2.2 Aluminium Door, Windows and Frames

Extruded sections shall have a minimum 3 mm wall thickness unless otherwise approved in samples by the architect/engineer. All sections shall be approved by the Architect/Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness. The anodized materials shall then be sealed by immersing in bailing water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory. Unless otherwise specified all aluminium doors and windows shall be anodised with 20 micron thick.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing or as specified in schedule of items. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.3.0 Shop Coat or Paint

The shop paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. which will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

All steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 oz. per sft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame which come in contact with masonry construction, shall, before shipment from workshop, be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.



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2.4.0

Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before despatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.5.0

Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louveres, etc. shall conform to IS:1081 and as shown on drawings. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louveres, etc. including transoms and mullions for composite units in respective places as shown on drawing, keeping proper lines and levels, and in approved workmanlike manner, to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop- coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres



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from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.0.0 ACCEPTANCE CRITERIA

3.1.0 For Fabricated Items

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.
- h) Provision for hardware and fixtures to be installed at site.
- i) Glazing beads shall be cut with mitred corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.2.0 For Installed Items

- a) Installations shall be at correct location, elevation and in general, on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc.



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complete.

- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners etc. shall engage positively. Keys shall be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.0.0

I.S. CODES

Following are some of the important I.S. Codes as relevant to this section :

Steel doors, windows and ventilators	-	IS:1038
Steel windows for industrial buildings	-	IS:1361
Aluminium doors windows and ventilators	-	IS:1948
Aluminium windows for industrial buildings	-	IS:1949
Steel door frames	-	IS:4351
Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows, and ventilators	-	IS:1081



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
GLASS AND GLAZING**

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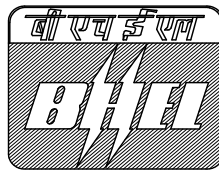
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

GLASS AND GLAZING



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
GLASS AND GLAZING**

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**TECHNICAL SPECIFICATION
FOR
GLASS AND GLAZING**

1.0.0 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall not be included in this scope.

This shall also include the fixing of all glass and glazing supplied by the Owner at his site stores.

2.0.0 INSTALLATION

2.1.0 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvres, miscellaneous glazing and partitions, unless otherwise stated from approved manufacturer having uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

2.2.0 Materials

- a) Glare reducing or heat absorbing glass shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Glass shall be float glass of required thickness and shall be clear or tinted as indicated.
- c) Wired glass shall be thick rolled glass with centrally embedded 42g. wire mesh of Georgian type. This may be of clear or coloured glass, as shown on drawings.
- d) Obscure glass shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS : 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.
- g) EPDM gaskets with snap-fit glazing beads shall be fixed as per



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TECHNICAL SPECIFICATION FOR
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manufacturer's instructions and shall sit snugly against glass to give a leakproof installation.

- h) Float glass
- i) Double glazing

2.3.0 Glazing, Setting and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glasspane, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones.

3.0.0 ACCEPTANCE CRITERIA

- a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leakproof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.0.0 I.S. CODES



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Following are some of the important I.S.Codes relevant to this Section :

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows & ventilators.



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TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS/GRILLS**

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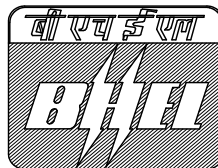
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROLLING STEEL SHUTTERS/GRILLS



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS/GRILLS**

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**TECHNICAL SPECIFICATION
FOR
ROLLING STEEL SHUTTERS/GRILLS**

1.0.0 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.0.0 INSTALLATION

2.1.0 Components

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 2.25 mm thick for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.
- f) Shafts shall be of steel pipe of sufficient size to carry the torsion load with a maximum deflection of 1/360th of span.

Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described



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in Schedule or as described by the Engineer.

- i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

- j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.
- k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.2.0 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 Sq.metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described as desired by the Engineer.

2.3.0 Power Operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.4.0 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.5.0 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.



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3.0.0 ACCEPTANCE CRITERIA

3.1.0 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.2.0 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.3.0 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.0.0 I.S. CODE

IS : 6248 - Metal rolling shutters and rolling grills.



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TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL**

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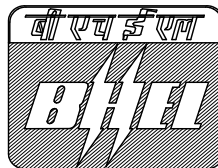
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GENERAL TECHNICAL SPECIFICATION

MISCELLANEOUS METAL



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
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**TECHNICAL SPECIFICATION
FOR
MISCELLANEOUS METAL**

1.0.0 SCOPE

This specification shall generally be read in conjunction with item nos. 6.01 & 6.03.

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described.

2.0.0 INSTALLATION

2.1.0 Fabrication/Casting

2.1.1 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.1.2 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel.
- c) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.1.3 Shop Coat



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Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer.

2.2.0 Erection

2.2.1 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.2.2 Temporary Bolting-Up

As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.2.3 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.2.4 Welding

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

2.2.5 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.



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TECHNICAL SPECIFICATION FOR
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2.2.6 Drifting

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.2.7 Grouting

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

2.2.8 Anchor Bolting

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.2.9 Pipe Joints

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.2.10 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

2.2.11 Making Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.



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3.0.0

ACCEPTANCE CRITERIA

- a) All items shall be of correct shape, size, weight etc. shown on drawings.
- b) For installed items, the tolerances shall be follows :
 - i) Permissible deviation from straightness - 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blow holes, cracks and other blemishes.

4.0.0

I.S. CODES

- IS : 226 - Structural Steel (Standard Quality)
- IS:800 - Code of practice for use of structural steel in general building construction.
- IS : 816 - Use of metal arc welding for general construction in mild steel.
- IS : 2812 - Arc welding of Aluminium and Alloys
- IS : 3150 - Hexagonal Wire Netting
- IS : 4948 - Welded steel wire fabric for general use.



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TECHNICAL SPECIFICATION FOR
PAINTING,WHITE WASHING AND
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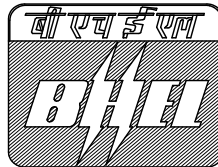
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GENERAL TECHNICAL SPECIFICATION

PAINTING, WHITE WASHING AND POLISHING ETC.



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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**TECHNICAL SPECIFICATION
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.**

1.0.0 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster or paris, Punning false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

2.0.0 INSTALLATION

2.0.1 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible & paint or one shade is obtained the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.



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All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **White Washing**

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Engineer; and shall conform to IS:712 latest edition. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

b) **Dry distemper**

Shall be made from suitable pigments, extenders, lime proof tinters, water soluble binders etc. and shall conform to IS:427.

c) **Oil Bound Washable Distemper**

Shall be of oil emulsion type, containing suitable preservatives and shall conform to IS:428.

d) **Waterproof Cement Paint**

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS:5410.

e) **Acrylic Emulsion Paint**

Shall be water-based acrylic copolymer emulsion with ritle titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Synthetic Enamel Paint**

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable



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and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS:2932 and IS:2933.

g) **Aluminium Paint**

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS:2339.

h) Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) **French Polish**

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS:348.

French polish shall not be used on bare wood. It shall only be used as finishing coat on wood after the wood is pretreated with a liquid wood filler conforming to IS:345 is applied and rubbed out.

2.0.2 **Storage**

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Contractor to prevent fire.

2.1.0 **Preparation of surface**

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.1.1 **Wood**

All surfaces shall be free from dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellac coating applied thinly & extended 25 mm beyond the area. All large, loose or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS:2338.

2.1.2 **Masonry, Concrete and Plastered Surface**

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and



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patch filled with mortar similar to the original surface and uniformly textured. Where this type of re- surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below :

a) **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammonia cal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.1.3 **Metal**

All metal surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanised iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

2.2.0 **Application**

2.2.1 **General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is



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drying. Application of paint, which seals the surfaces to moisture, shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall be done as per IS:1477 (Part 1 & 2). The total dry thickness of the film should not be less than 120 micron.

2.2.2 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before application of the lime solution.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required. No brush marks shall show on the finished surface.

2.2.3 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms. of zinc sulphate to 1 litre of water and then allowed to dry.

Dry distempering shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

2.2.4 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.



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2.2.5 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.2.6 Acrylic Emulsion Paint

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

2.2.7 Synthetic Enamel Paint

Shall be applied on properly prime red surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.2.8 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.2.9 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on while the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has began to set, shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.



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The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flattened down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.2.10 French Polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt sienna or umber.

After application of the filler paste, the french polish shall be applied with a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for ease of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly dampened with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.2.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber or vinyl butyl paint system shall be used manufacturer's recommendation regarding the paint system exposed to moderately severe corrosive condition and subject to acid/alkali spillage and fumes, shall be followed.

2.2.12 Epoxy coating/painting

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification :

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with leveling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight



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HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 - 15 Parts by weight

SILICA FLOUR - 20 Parts by weight

**FLOW CONTROL
AGENT - 2 Parts by weight**

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

2.3.0 Protection

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.4.0 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipments, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.0.0 ACCEPTANCE CRITERIA

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

4.0.0 I.S. CODE

Important relevant IS Codes for this Sections are listed below :

IS:348 : Specification for French Polish

IS:427 : Specification for Distemper, dry colour as required.



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- IS:428 : Specification for Distemper oil emulsion, colour as required.
- IS:1477 : Code of Practice for painting of ferrous (I&II)metal in buildings.
- IS:2338 : Code of Practice for finishing of wood (I&II)and wood based materials.
- IS:2339 : Specification for Aluminium Paints for general purposes in dual containers.
- IS:2395 : Code of Practice for painting concrete, masonry and plaster surface.
- IS:2932 : Specification for enamel, synthetic, exterior, type-I.
- IS:5410 : Specification for cement paint, colour as required.



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TECHNICAL SPECIFICATION FOR
ROOF WATERPROOFING,INSULATION
AND ALLIED WORKS**

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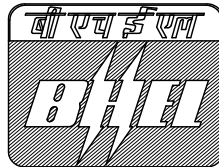
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GENERAL TECHNICAL SPECIFICATION

**ROOF WATER PROOFING, INSULATION AND ALLIED
WORKS**



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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**TECHNICAL SPECIFICATION
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**

1.0.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.0.0 INSTALLATION

2.1.0 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.1.1 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.2.0 Concrete

The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable. The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

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2.3.0

Insulation

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.3.1

Foam Concrete

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.3.2

Expanded Polystyrene Blocks

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision.

Either of above items (cl. No. 2.03.01 or 2.03.02) can be adopted subject to approval of engineer.

2. 4.0

Fillets



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Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.5.0 Water proofing by epoxy resin based application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.6.0 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.7.0 Elastomeric Membrane

2.7.1 Primer Coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.



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The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.7.2 Finishing Coats

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.7.3 Surface Finish

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.0.0 ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and



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shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a 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 a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.0.0

I.S. CODES AND STANDARDS

- a) IS:73 : Paving Bitumen
- b) IS:702 : Industrial Bitumen
- c) IS:1203 : Methods of testing tar and bitumen
- d) IS:1322 : Bitumen felts for waterproofing and damp proofing
- e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts
- f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.



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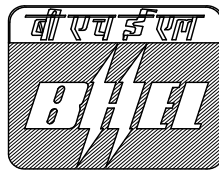
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GENERAL TECHNICAL SPECIFICATION

SHEETING WORK IN ROOF AND SIDING



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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**TECHNICAL SPECIFICATION
FOR
SHEETING WORK IN ROOF AND SIDING**

1.0.0 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc., as shown on drawings.

2.0.0 INSTALLATION

2.1.0 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.2.0 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.2.1 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge capping, corner pieces, ventilators, north light curves etc.

2.2.2 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground the sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washes. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J- bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation



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with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

2.2.3

Fibre Glass Reinforced Plastic Sheet

This shall be of thickness and profile as mentioned in the drawing. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in drawing. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

3.0.0

ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

- a) Side and end laps
- b) Absence of cracks, holes or damages in sheet
- c) Spacing of bolts
- d) Provision of double washers (G.I. and asbestos or bituminous washers)
- e) Proper installation of flashing

4.0.0

IS CODES

The following are some of the important IS Codes relevant to this sections :

- IS : 3007 : Code of practice for laying of asbestos cement sheets.
- IS : 2527 : Code of practice for fixing rain water gutters and down pipes for roof drainage.
- IS : 1626 : Specification for asbestos cement building pipes gutters and fittings.
- IS : 277 : Specification for galvanised steel sheets (plain and corrugated).



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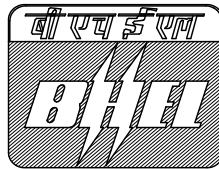
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GENERAL TECHNICAL SPECIFICATION

WATER SUPPLY



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
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**TECHNICAL SPECIFICATION
FOR
WATER SUPPLY**

1.0.0 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.0.1 Materials

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.0.2 Pipes and Pipe Fittings

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

- a) Cast Iron
- b) Steel : lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.
- c) Reinforced Concrete
- d) Prestressed Concrete
- e) Lead (Not to be used for potable water)
- f) P. V. C.
- g) Copper



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h) Brass

i) Wrought iron

1.0.3 Water Reservoirs

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.0.4 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded.

1.0.5 Regulation

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

2.0.0 INSTALLATION

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.1.0 Pipe Lines

2.1.1 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or



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concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.1.2 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.1.3 Contamination

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.1.4 Underground Pipings

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.1.5 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.1.6 Jointing of Pipes



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Jointing of pipes shall be completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance :

a) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **GI Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

e) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

f) **P. V. C.**



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Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

g) Tyton Joint

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

2.1.7 Painting

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.2.0 Storage Tank - Pressed Steel Tank

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.2.1 G. I. Water Tank

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to angle framing



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at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. White lead shall be applied to the joints before rivetting.

In case it is desired by the Engineer that corners of tank should be welded instead of rivetted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.3.0 Valve, Cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.4.0 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.0.0 TESTING AND ACCEPTANCE



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3.1.0 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.2.0 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.3.0 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All pipings, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.0.0 I.S. CODES

Important relevant IS Codes for this Specification are listed below :
Latest editions shall always be consulted.

IS:2065 : Code for Practice for water supply in buildings

IS:1172 : Code of basic requirements for water supply, drainage and sanitation

IS:1200 (Pt. XVI) : Laying of water and sewer lines including appcurtnant items.



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- IS:1239 : Specification for Mild Steel Tubes and Mild Steel Tubulars
(Pt. I & II) and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
- IS:1536 : Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
- IS:1537 : Specification for vertically cast iron pressure pipes for water, gas and sewage.
- IS:3486 : Specification for Cast iron spigot and socket drain pipes (80 mm to 250 nominal diameter)
- IS:3589 : Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
- IS:784 : Prestressed concrete pipes
- IS:458 : Concrete pipes (with or without reinforcement)
- IS:783 : Code of Practice for laying of concrete pipes
- IS:1592 : Asbestos cement pressure pipes
- IS:1626 : Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
- IS:404 : Lead pipes
- IS:3076 : Low density polyethylene pipes for potable water supplies
- IS:4984 : High density polyethylene pipes for potable water supplies
- IS:2501 : Copper tubes for general engineering purposes
- IS:407 : Brass tubes for general purposes
- IS:1230 : Cast iron rain water pipes and fittings
- IS:804 : Rectangular pressed steel tanks



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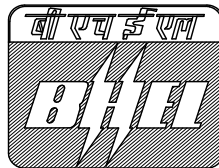
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

DRAINAGE AND SANITATION



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



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**TECHNICAL SPECIFICATION
FOR
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1.0.0 SCOPE

1.1.0 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.0.0 INSTALLATION

2.0.1 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.1.0 Rainwater Downcomers

Rainwater downcomers shall be standard Cast Iron Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.



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2.2.0 Gutters

The gutters shall be made of G.I. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.3.0 Soil and Drainage Pipes

2.3.1 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	: 1 in 35
150 mm nominal dia	: 1 in 65
230 mm nominal dia	: 1 in 120
300 mm nominal dia	: 1 in 200

2.3.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.3.3 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.



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2.3.4

Support and Protection on Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

- a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
- b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.
- c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.
- d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.3.5

Entry into structures



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For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.3.6 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.3.7 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.3.8 Manhole and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.3.9 Cutting of Pipes



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Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.3.10

Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) **Cast Iron Pipes**

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) **Concrete Pipes**

Care shall be taken to place the collar centrally over the joint.



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2.4.0

Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.5.0

Fixtures

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.



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All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.5.1 Water closet

a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.5.2 Urinals

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.5.3 Wash basin

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.5.4 Sink

It shall be made of Marble or Granite . It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.



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2.5.5 Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.5.6 Glass shelves

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.5.7 Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.5.8 Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.5.9 Liquid soap dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.5.10 Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.5.11 Installation

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.6.0 Septic tank & effluent disposal

2.6.1 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.6.2 Effluent Disposal



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The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed CI pipes laid in a trench filled with broken bricks.

2.6.3 Soak pit / Chlorination Chamber

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.6.4 Joining C.I. Pipes / dispersion trenches

Minimum dia of the CI pipe shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be made with lead. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.6.5 Commissioning septic tank and Soak pit/Chlorination Chamber

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.0.0 TESTING AND ACCEPTANCE

3.1.0 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.2.0 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test



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All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and



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- ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.3.0 Testing Septic Tank

The septic tank shall be tested for watertightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.4.0 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.0.0 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed : Latest editions shall always be consulted.

- IS:1172 - Code of basic requirements for water supply drainage and sanitation.
- IS:1200 - Laying of water and sewer lines including appurtenant items.
(Pt. XVI)
- IS:1239 - Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings.
(Pt. I & II)
- IS:1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
- IS:1537 - Vertically cast iron pressure pipe for water, gas & sewage.
- IS:3486 - Cast Iron spigot & socket drain pipes.
- IS:1742 - Code of Practice for building drainage.
- IS:5329 - Code of Practice for sanitary pipe work above ground for buildings.
- IS:2470 - Code of Practice for designs and construction of septic tank for small and large installations.
- IS:3076 - Low density polythelene pipes for potable water supplies.
- IS:4984 - High density polythelene pipes for potable water supplies.
- IS:1537 - Vertically cast iron pressure pipes for water, gas and sewage.



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- IS:1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.
- IS:1230 - Cast Iron rain water pipes and fittings.
- IS:3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.
- IS:1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.
- IS:1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).
- IS:458 - Concrete pipes (with and without reinforcement)
- IS:783 - Code of Practice for laying of concrete pipes.
- IS:784 - Prestressed concrete pipes.
- IS:651 - Salt glazed stoneware pipes & fittings.
- IS:4127 - Code of practice for laying of glazed stoneware pipes.
- IS:1726 - Cast Iron manhole covers and frames intended for use in drainage works.
- IS:5961 - Cast Iron gratings for drainage purposes.
- IS:5219 - 'P' & 'S' traps.
(Part-I)
- IS:771 - Glazed earthen-ware sanitary appliance.
- IS:772 - General requirements of enamelled cast iron sanitary appliances.
- IS:774 - Flushing cistern for water closets & urinals (valveless siphonic type).
- IS:775 - Cast Iron brackets & supports for wash basins and sinks.
- IS:2548 - Plastic water closet seats & covers.
- IS:2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.



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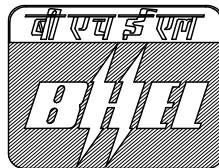
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SECTION - D

GENERAL TECHNICAL SPECIFICATION

ANTI-TERMITE TREATMENT



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

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**TECHNICAL SPECIFICATION
FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	: 1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M² of surface area. Backfills around columns, walls etc. shall be



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treated at the rate of 7.5 litres / M² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 RATES



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Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00

METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, buried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00

I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.



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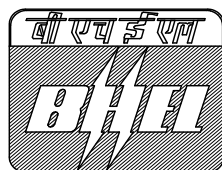
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SITE LEVELING AND GRADING



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GENERAL TECHNICAL SPECIFICATION
FOR
SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **“Site Levelling and Grading Works including Slope Protection”** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.



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2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works,
Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground
blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.



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a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02

Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

- a) Materials from swamps, marshes and bogs
- b) Expansive clays
- c) Peat, logs, sod and perishable materials
- d) Materials susceptible to combustion
- e) Any material or industrial and domestic produce which will adversely affect other materials of work
- f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with



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the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm



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layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or 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. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne



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roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

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. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to



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transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation 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 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the 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 well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not 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 be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.



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Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The 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 the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall 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 the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives



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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 his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him 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 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

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 etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be



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present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as far as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials



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Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720, part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate



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of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any



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debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughened** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are 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 edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

a) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.



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6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.



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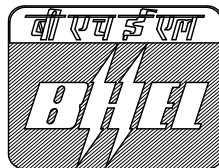
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BORED CAST-IN-SITU RCC PILES

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Bharat Heavy Electricals Limited

Project Engineering Management
Power Sector, BHEL House
Asian Games Village Complex
Siri Fort, New Delhi-110049



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TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED
CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENT

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

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2.09.00	The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.	
2.10.00	In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.	
2.11.00	In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.	
2.12.00	It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.	
2.13.00	The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.	
2.14.00	The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.	
2.15.00	AVAILABLE SUB-SOIL DATA An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.	
3.00.00	MATERIALS	



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3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content
Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter



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of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

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4.01.04	Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.	
4.02.00	Installation Criteria	
4.02.01	For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.	
4.02.02	For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of Nx size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.	
4.02.03	In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.	
4.02.04	Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.	
4.02.05	A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.	
4.02.06	The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.	
4.02.07	Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.	
4.03.00	Control of position and alignment	
4.03.01	Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.	



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- a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.
- b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more than 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.



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4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

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4.08.04	Proper placement of the reinforcement cage to its full length shall be ensured before concreting.	
4.08.05	Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.	
4.08.06	The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.	
4.08.07	Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.	
4.08.08	It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.	
4.08.09	The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.	
4.09.00	Cut off level (COL)	
4.09.01	Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.	
4.09.02	The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.	
4.09.03	When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.	
4.10.00	Sequence of Piling	
4.10.01	Each pile shall be identified with a reference number.	
4.10.02	The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.	
4.11.00	Building up of Piles	

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4.11.01	If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.	
4.12.00	Breaking off of Piles	
4.12.01	If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.	
4.13.00	Preparation of Pile head	
4.13.01	The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.	
4.13.02	The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.	
4.13.03	The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.	
4.13.04	The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.	
4.13.05	All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.	
4.14.00	Rejection and Replacement of Defective Piles	
4.14.01	The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.	
4.15.00	Recording of Piling Data	

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4.15.01	The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.	
5.00.00	SAMPLING, TESTING AND QUALITY ASSURANCE	
5.01.00	Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.	
5.02.00	The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.	
5.03.00	Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shall be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.	
5.04.00	Quality Assurance Programme - The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results. - Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified	



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requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimens vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

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5.08.01	On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.	
5.08.02	For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted. a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content. b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.	
5.09.00	Pile Integrity test	
5.09.01	Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test. Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.	
5.09.02	The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.	
5.09.03	Low Strain Integrity Test Methodology: a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test. b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis. c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within	



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its length these will set up secondary reflections, which will be added to the return signal.

- d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.
- e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.
- f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.
- g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect



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of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- IS: 432 - Specification for mild steel and medium tensile steel bars (Part 1 & 11) and hard drawn steel wire for concrete reinforcement.
- IS: 456 - Code of practice for plain and reinforced concrete.
- IS: 1200 - Measurement of Building and Civil Engineering works (Part 23) Piling.
- IS: 1786 - Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
- IS: 1892 - Code of practice for Subsurface Investigation for foundation.
- IS: 2131 - Method of Standard Penetration Test for Soils
- IS: 2911 - Code of practice for design and construction of pile Part I/Sec 2 foundations - Bored cast-in-situ concrete piles.
- IS: 2911 - Code of practice for design and construction of pile Part IV foundation - Load test on piles.
- IS: 6926 - Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.
- IS: 10262 - Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions,

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	local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer. 8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work. 8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification. 8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner. 8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results. 8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc. 8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock. 8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer. 8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.	

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8.02.11	Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.	
8.01.12	The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.	
8.01.13	The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.	
8.01.14	Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not have been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.	
8.02.00	Measurement	
8.02.01	Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.	
8.02.02	Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:	
	i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.	
	ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.	
	iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.	



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- 8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.
- 8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.
- 8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.



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ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pul lout/Tension (MT)
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

- Minimum length of the pile shall be _____* m below COL.
- The pile shall be terminated after penetrating through the strata having SPT penetration less than ____* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

- Piles shall be installed and socketed into the rocks for a length (socketing length) equal to ____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.
- Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____* m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria



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Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.



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ANNEXURE-B

List of Equipments

Sl.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.



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ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

- a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.
- b) Sand content of the bentonite powder shall not be greater than 7 percent.
- c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.
- d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.
- e) The differential free swell shall be more than 540 percent.
- f) The pH value of the bentonite suspension shall be between 9 and 11.5.



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ANNEXURE-D
PILE DATA

1. Reference No. Location (Co-ordinates) _____ area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:
 - i) Freshly supplied mud
Liquid limit -

Sand content -

Density -

Marsh viscosity -

Swelling index -

pH value -
 - ii) Contaminated mud
Density -

Sand content -
14. SPT* N values in soil (from the nearest bore hole).



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+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test

** Unconfined compression strength

15. Chiseling if any, from..... m to m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity

Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement

No. _____

Dia. _____

Depth _____

Stirrups: Type

No. _____

Dia. _____

Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.



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TABLE -1
FREQUENCY OF SAMPLING AND TESTING

Sl. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored material cuttings debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	Slump cone test Compressive Strength test	Each pile As per spec.	As per Cl. 5.5 As per Cl. 5.5	As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

ANNEXURES



**TITLE: - 2 X 660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION :

REV.NO. 00

SHEET

KHARGONE SUPER THERMAL POWER PROJECT

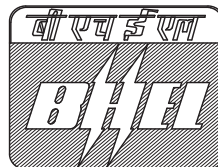
2 X 660 MW

**TECHNICAL SPECIFICATIONS
(INTAKE WATER PUMP HOUSE COMPLEX)**

CIVIL , STRUCTURAL & ARCHITECTURAL WORKS

FOR INTAKE WATER PUMP HOUSE COMPLEX

PE-TS-K13-600-C001



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, PPEI BUILDING

SECTOR 16A, NOIDA-201301



**TITLE: - 2 X 660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION :

REV.NO. 00

SHEET

PREAMBLE

This specification is intended for finalization of Pre bid tie up between PEM & Bidder.

Standard technical details as indicated in specification shall be agreed upon between BHEL & Bidder.

Technical requirements are stipulated in this Volume which comprises of

- Section A : This section outlines the scope of work
- Section B : This section provides 'Project Information' not covered
in 'Project Synopsis' , if any
- Section C : This section indicates the technical requirements
specific to the contract not covered in Section D
- Section D : This section comprises of technical specification(s)
-
- Annexures I : Hydrographic survey for intake Pump house
- Annexures II : Layout of Intake pump house
- Annexures III : Layout of switchgear building complex
- Annexures IV : GA of Transformers
- Annexures V : Contour survey and Terminal points

The requirements mentioned in the Section C shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the Section D in the specification.



**TITLE: - 2X660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

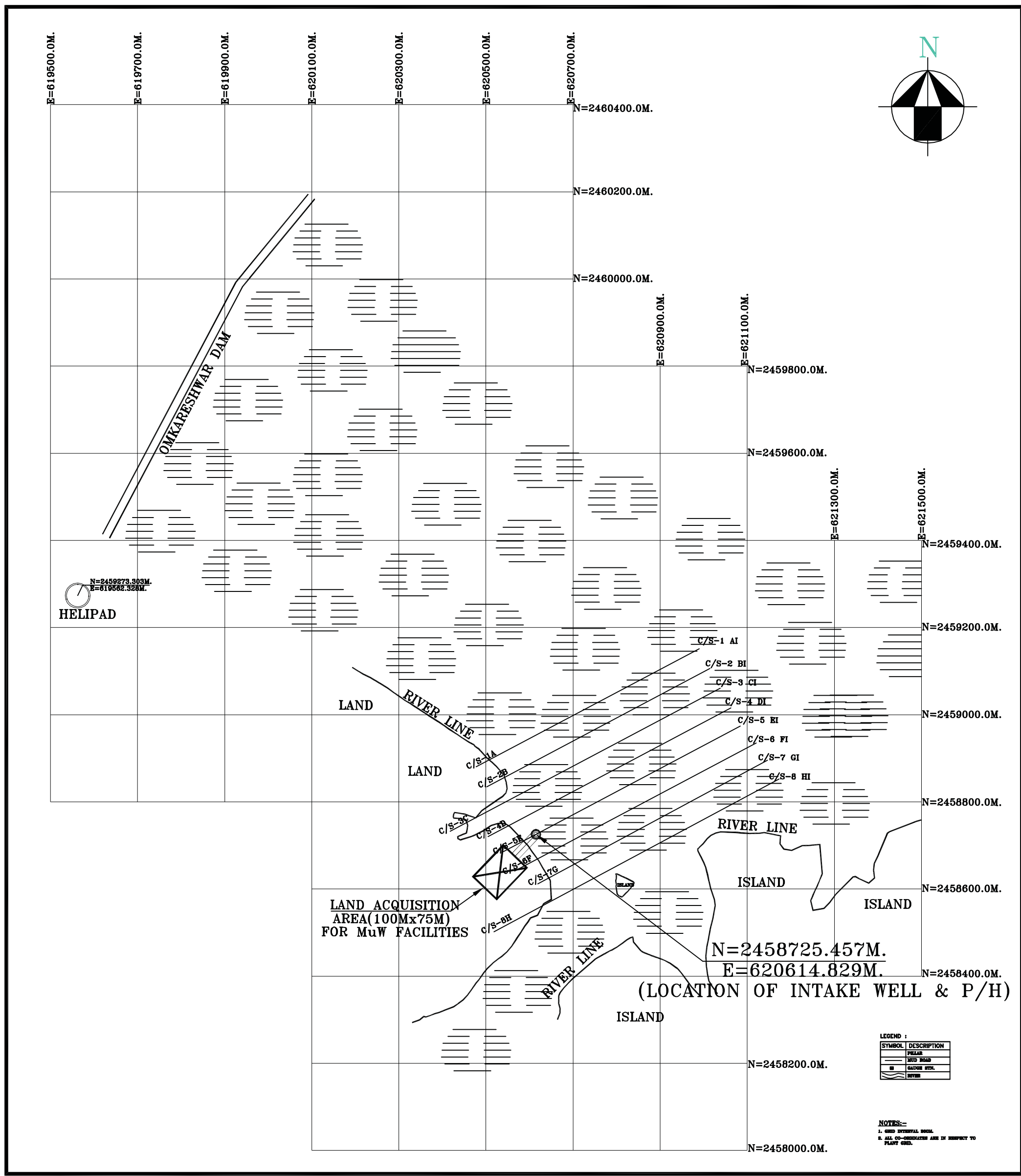
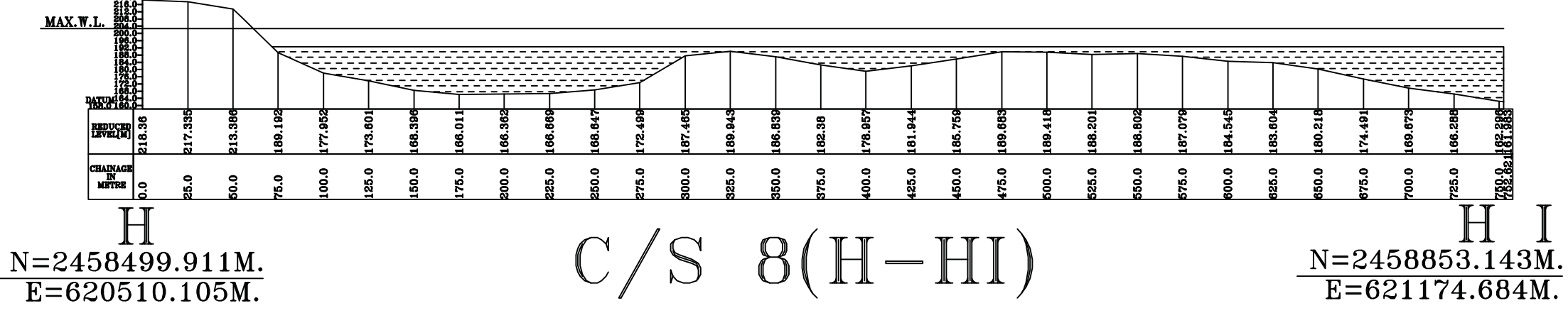
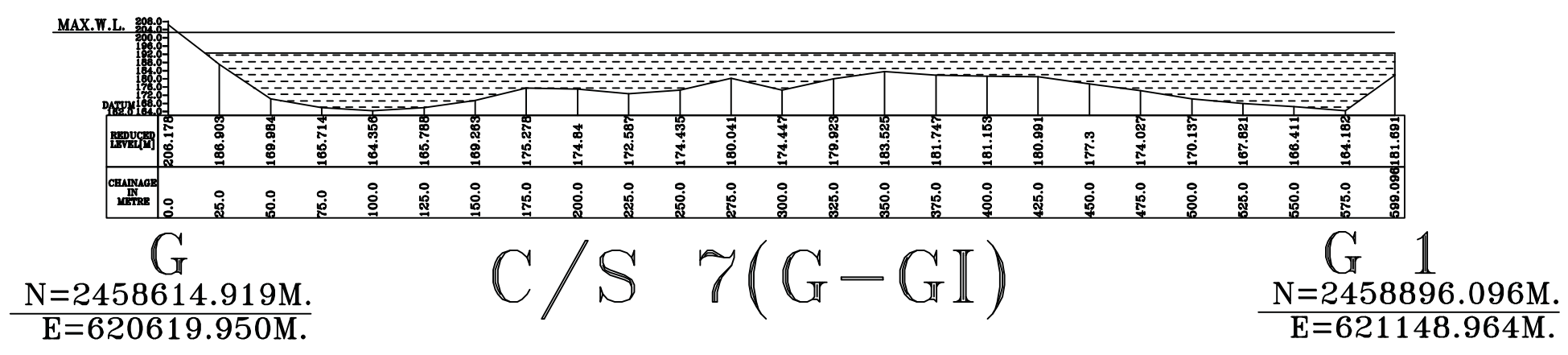
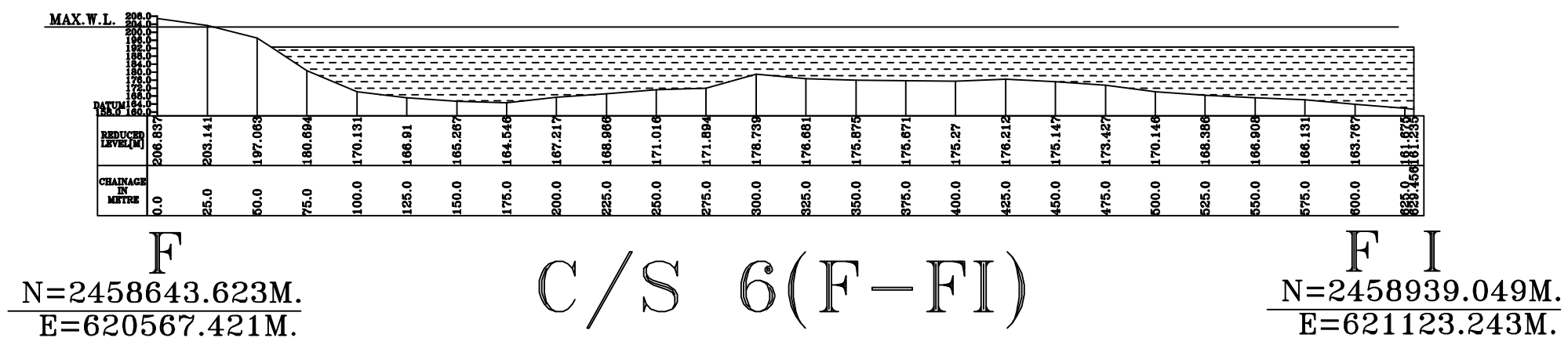
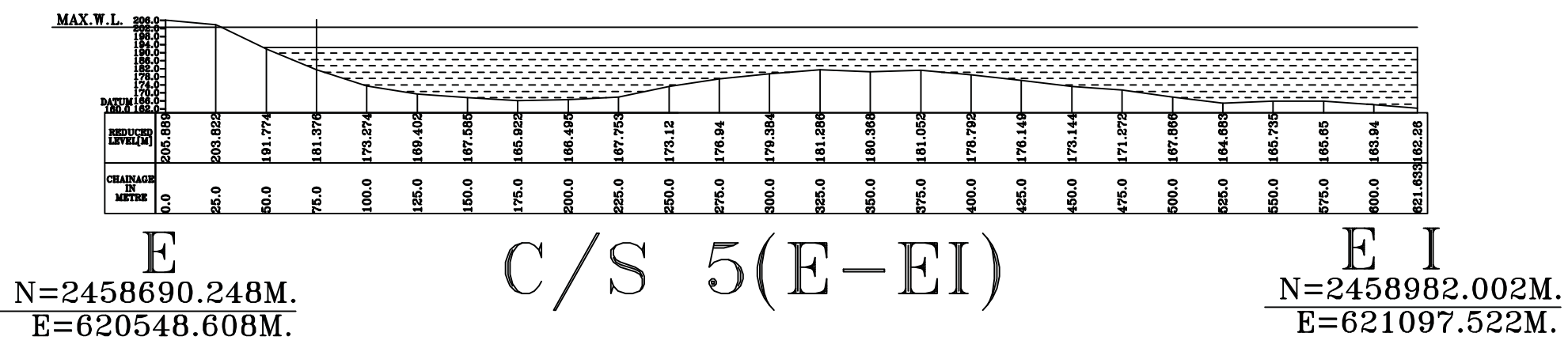
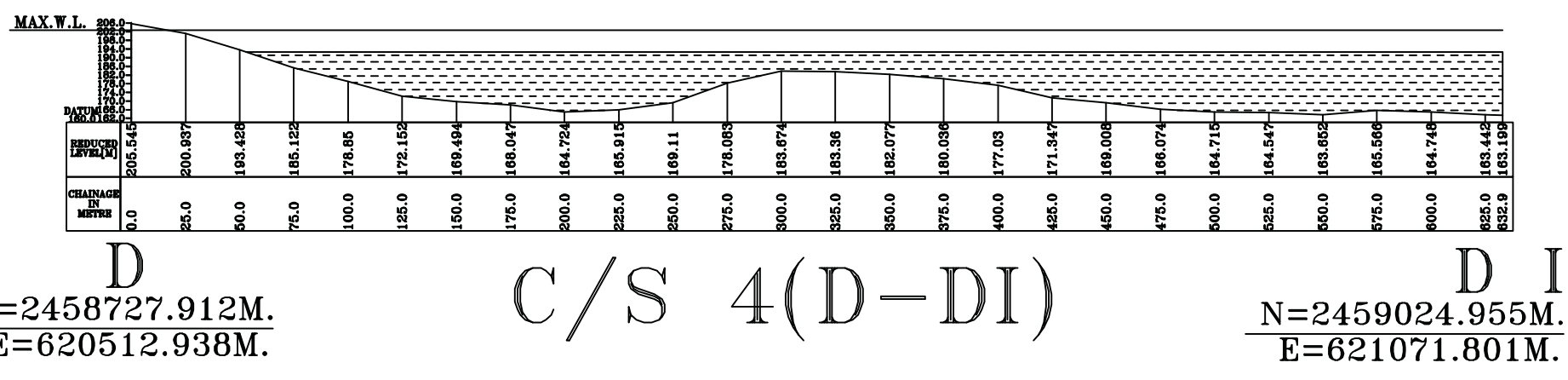
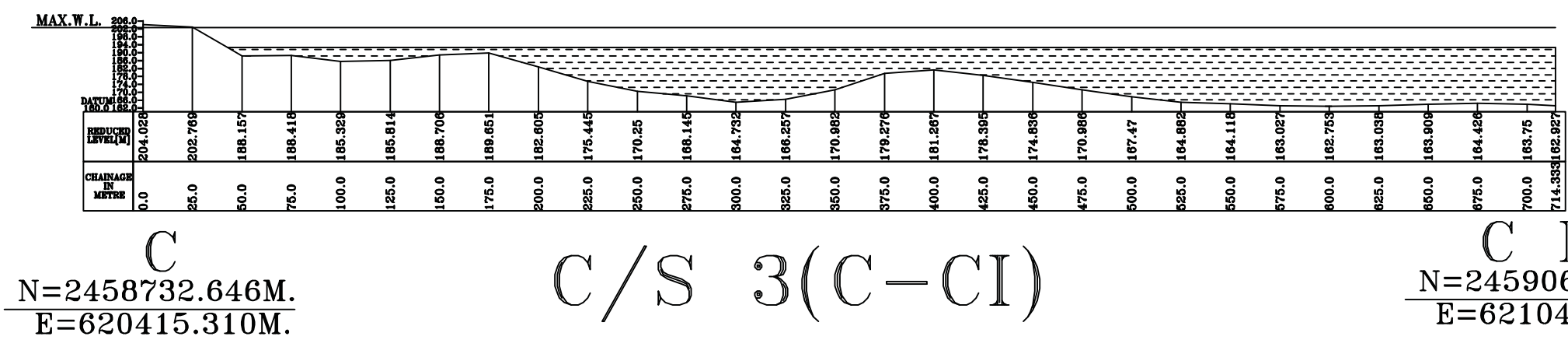
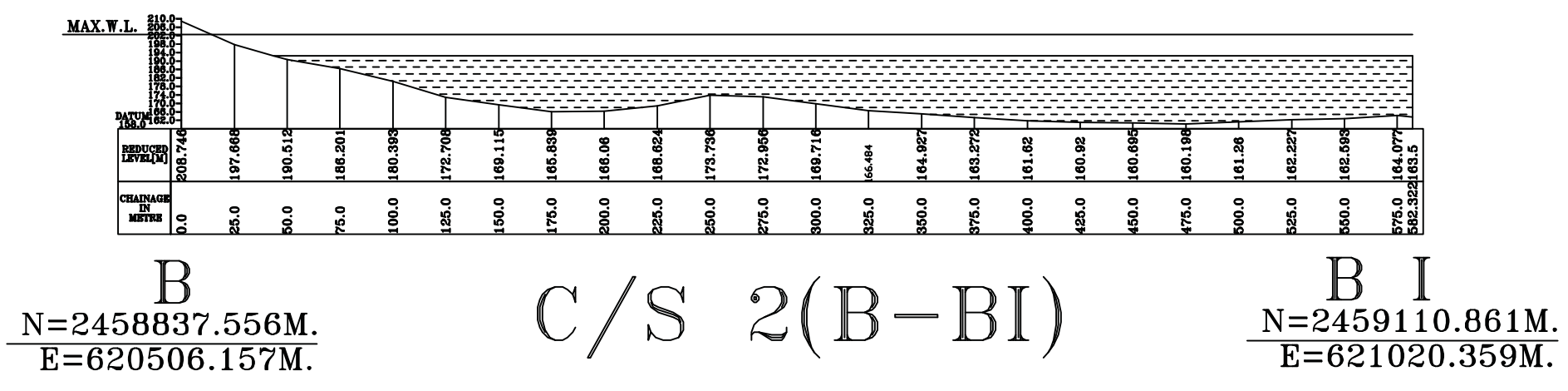
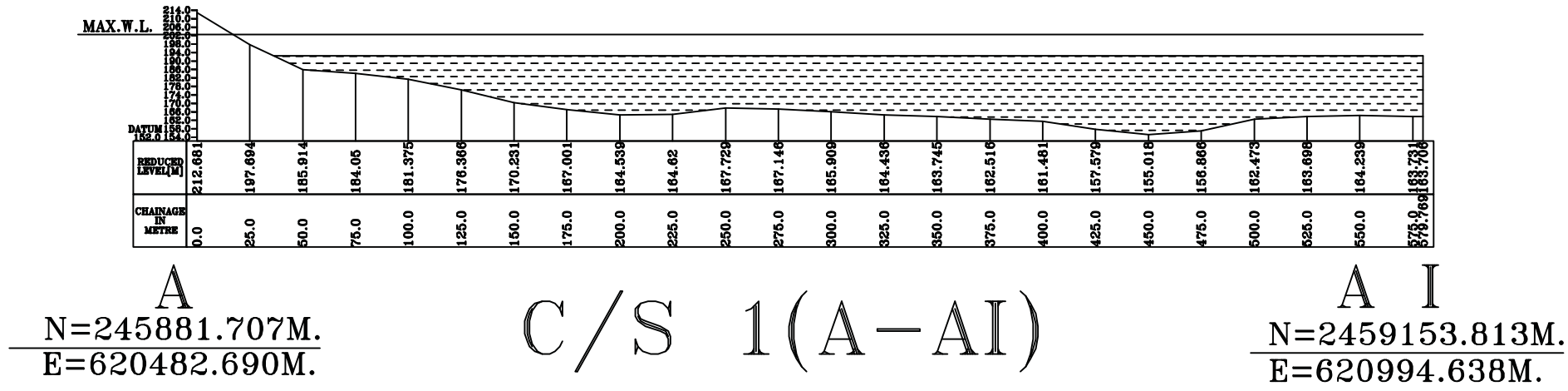
SECTION

REV.NO. 00

SHEET

ANNEXURES

Annexure I : Hydrographic survey of intake PUMP HOUSE

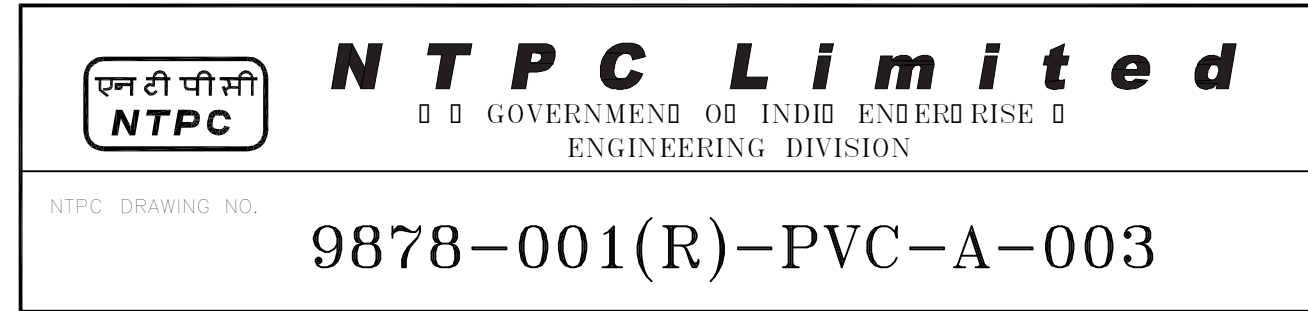


KEY PLAN

NOTES:—

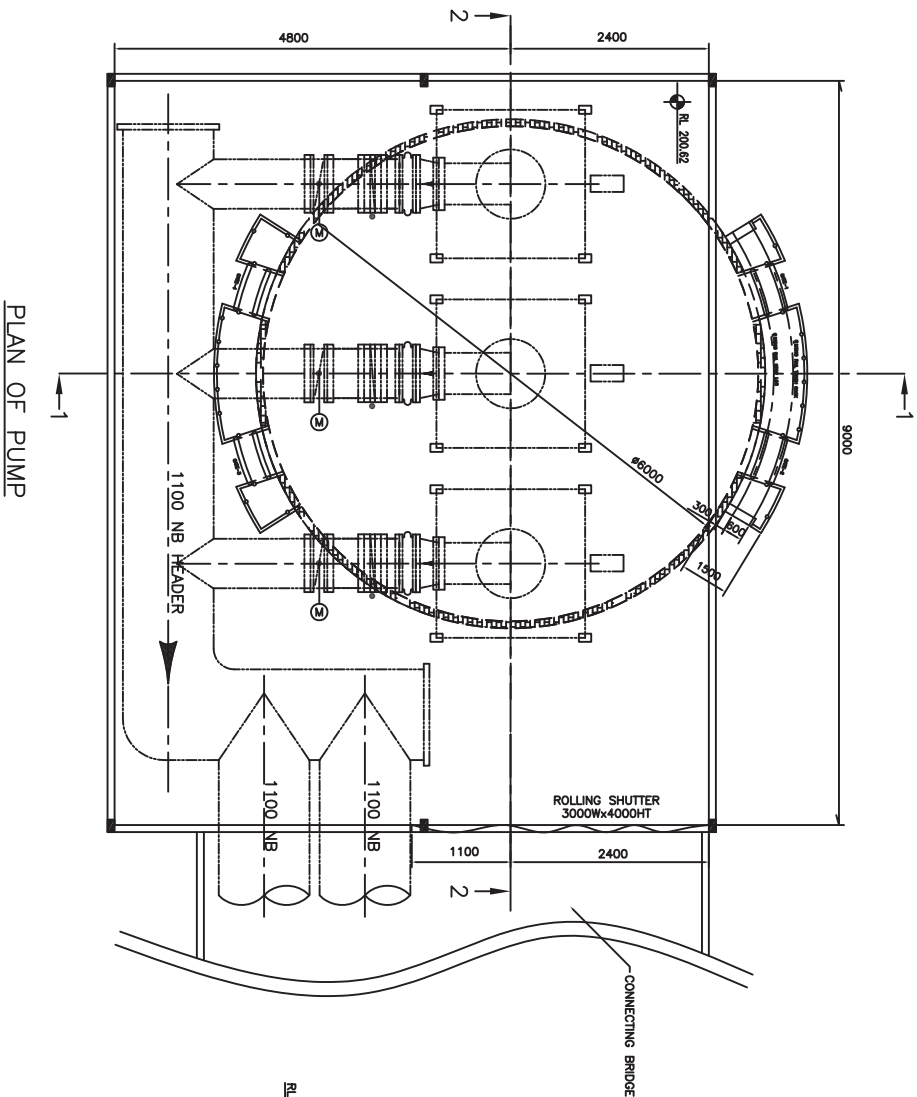
1. ALL DIMENSIONS ARE IN METERS.
2. WATER LEVEL(AVG.) 192.420M
3. ALL CO-ORDINATES ARE IN RESPECT TO LATITUDE & LONGITUDE RECEIVED FROM DGPS OBSERVATION.
4. ALL RL'S ARE IN RESPECT TO THE GTS BM NO.159/55B SITUATED AT THE ABUTMENT OF RAILWAY BRIDGE NO.813 OVER THE RIVER NARBADA. VALUE: 183.62M.
CO-ORDINATE: 2457516N/607532E
5. RL OF TOP OF OMKARESHWAR DAM AS PER GTS BM IS 205.84M.
RL OF TOP OF DAM AS PER DAM AUTHORITIES IS 203.00M.
6. MAXIMUM WATER LEVEL: 199.620M (AS PER DAM AUTHORITIES)
202.46M (AS PER GTS BM NO. 159/55B)

FOR TENDER PURPOSE ONLY



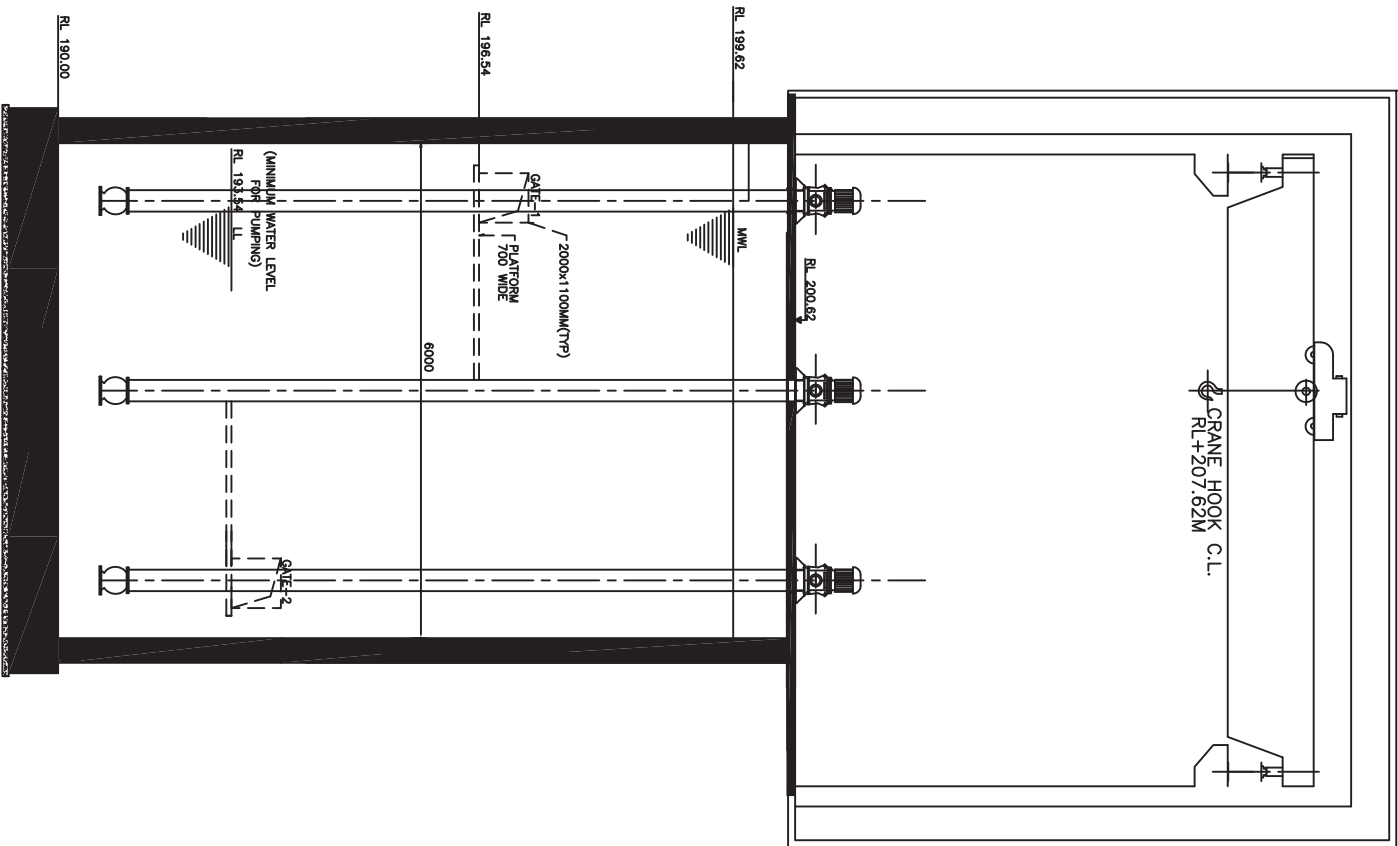
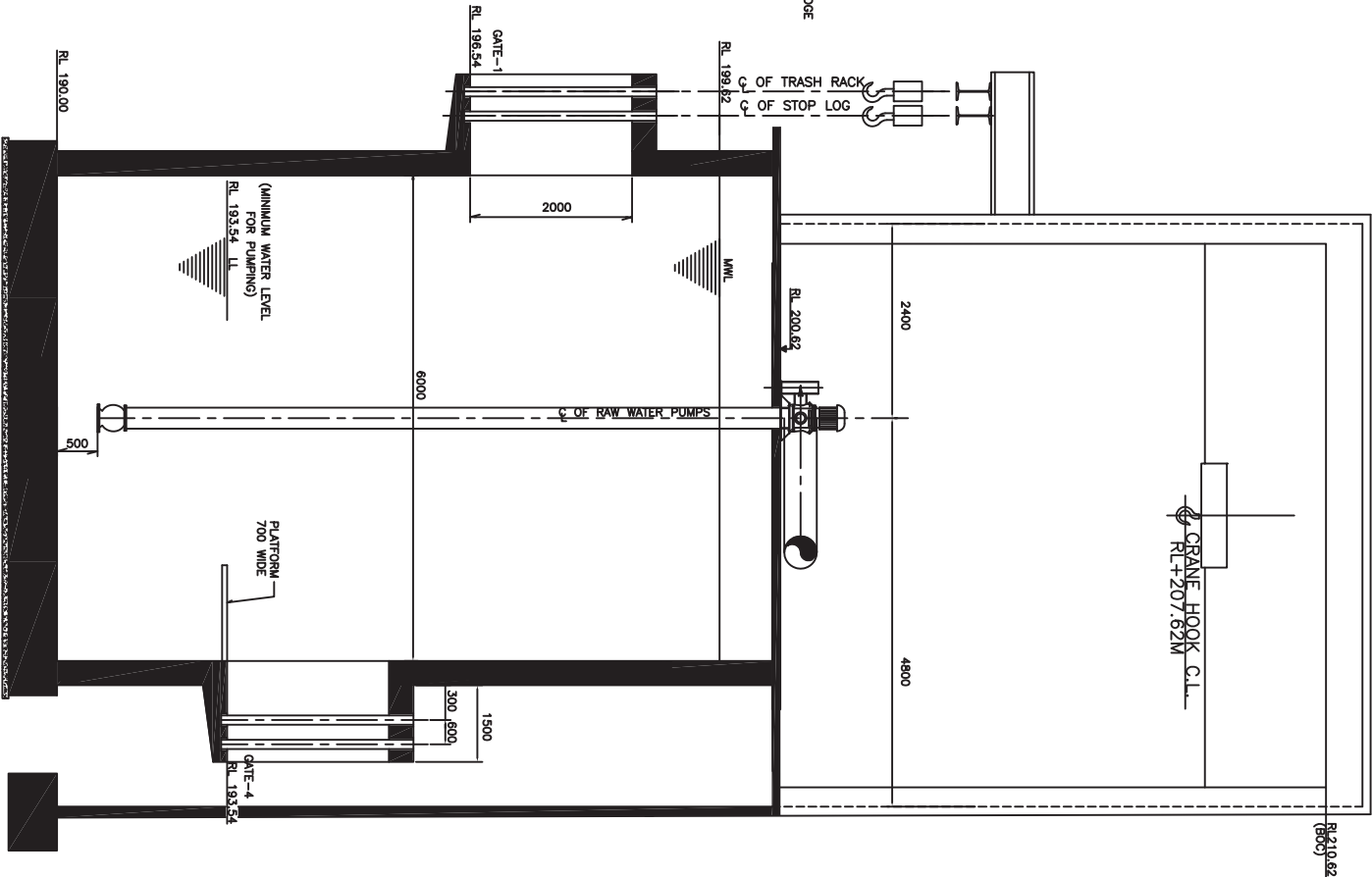
CLIENT :		NTPC LIMITED KHARGONE	
SURVEYED BY :		C & C CONSULTING FIRM 64A, HINDUSTAN PARK KOLKATA 700 029	
TITLE : HYDROGRAPHIC SURVEY DETAILS FOR INTAKE WATER PUMP HOUSE IN SUBMERGENCE OF OMKARESHWAR DAM		DRG. NO. -	
		SHEET NO.	REV.
		1	1
DRAWN BY	CHECKED BY	DATE	APPROVED BY
K.B.	S.C.	13.01.2012	
		SCALE	
		1:1000	

Annexure II : Layout of Intake Pump house



NOTES

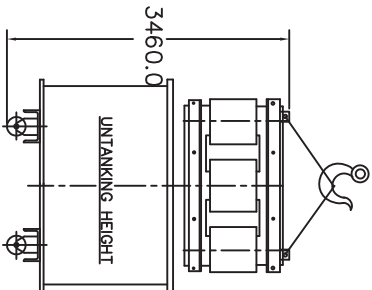
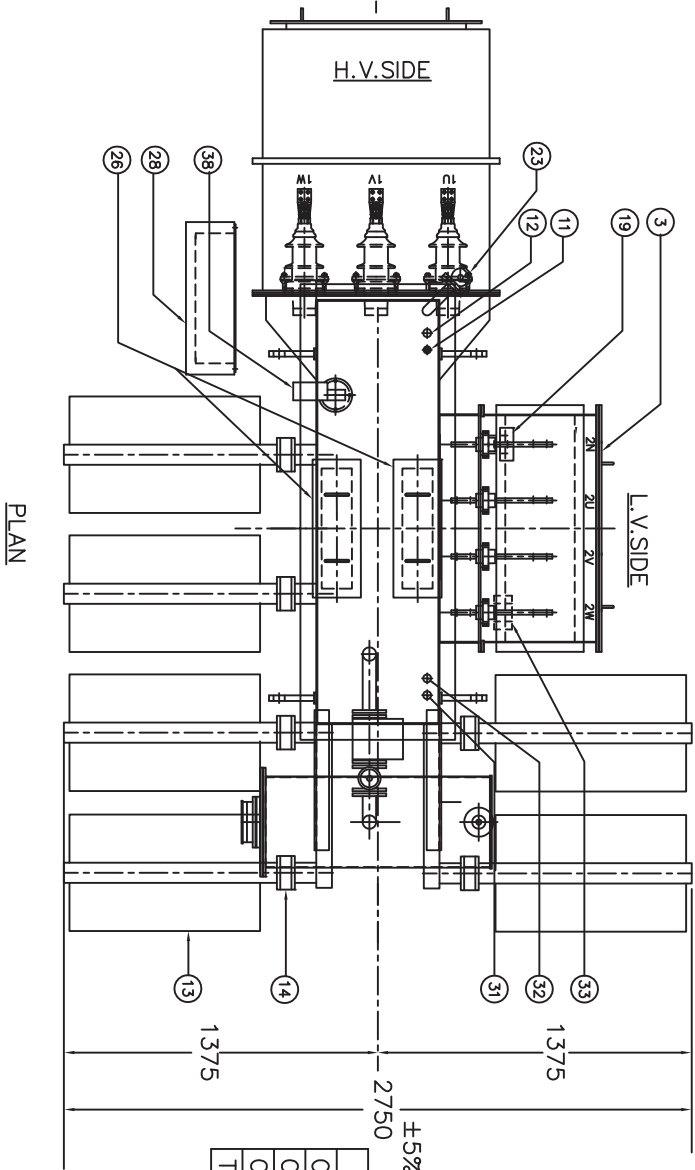
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS OTHERWISE SPECIFIED.
2. COLUMN PIPE SHOULD BE SUITABLY SUPPORTED. LOCATION OF THE SUPPORT TO SUIT SITE CONDITIONS.
3. CONCRETE PLATFORM SHALL BE DESIGNED FOR OPERATING, HANDLING, UNLOADING AND TEMPORARY STORAGE OF STOP LOGS AND SCREENS.
4. CLEAR WIDTH OPENING OF EACH GATE IS 1.1 M



FOR TENDER PURPOSE ONLY

OWNER										NTPC LIMITED																			
PROJECT										2x660 MW KHARGONE STPP																			
JDB NO. K-13																													
STATUS PROPOSAL																													
DISTRIBUTION (INTERNAL)																													
TO										BHARAT HEAVY ELECTRICALS LTD																			
NO.										POWER SECTOR																			
REV.					DATE					PROJECTS ENGINEERING MANAGEMENT					Noida														
					ALTD CHD APPD																								
TITLE																													
GENERAL ARRANGEMENT OF INTAKE WATER PUMP HOUSE																													
MAUX					MPL					C&I					DEPT.					SCALE 1:1					DRAWING NO.				
															SIGN										PE-DG-K13-172-N001				
															DATE										SHEET 1 OF 1 REV. 0				

Annexure IV : GA of Transformers



APPROXIMATE WT.	MIN ELECT. CLEARANCES
CORE & COIL	2600 kg
OIL WT.	1090 kg
OIL QUANTITY	1220 Ltrs
TOTAL WT.	6690 kg

- NOTES: —
- 1 ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED
 - 2 TAPINGS ON HV FOR HV VARIATION OF +5% TO -5% IN STEP OF 2.5% BY OCTC
 - 3 PAINT : EPOXY : SIEMENS GREY : SHADE NO. RAL-7032
 - 4 POSITION OF FITTINGS SHOWN ARE APPROXIMATE.
 - 5 * THUS MARKED ITEMS ARE TO BE DISMANTLED AT TIME OF TR. DESPATCH.
 - 6 HEIGHT OF BREATHER SHALL NOT BE MORE THAN 1500mm. FROM PLINTH LEVEL
 - 7 MATERIAL OF HV & LV WINDING IS COPPER.
 - 8 1LTR. OF PAINT SHALL BE SUPPLIED FOR TOUCH UP AT SITE
 - 9 10% EXTRA TR. OIL SHALL BE SUPPLIED IN NON RETURNABLE SEALED CONTAINERS.

38 PRESSURE RELIEF VALVE (70 Ø PORT OPENING) WITH TRIP CONTACT

37 VALVE POSITION INDICATING PLATE

36 ANTI EARTH QUAKE CLAMP

35 BOTTOM OIL SAMPLING VALVE (15mmØ SSF)WITH PLUG

34 GAS SAMPLING PIPE FOR BUCHHOLZ RELAY GAS (MAT. CU.TUBE)

33 W.T.I.C.T.

32 POCKET FOR W.T.I.

31 POCKET FOR O.T.I.

30 150 mm DIAL W.T.I. WITH M.R.P. R.S.D.AND ALARM AND TRIP CONTACT.

29 150 mm DIAL O.T.I. WITH M.R.P. R.S.D. AND ALARM AND TRIP CONTACTS

28 MARSHALLING BOX

27 LIFTING LUGS FOR COMPLETE TRANSFORMER

26 INSPECTION COVER

25 SHUT OF VALVE (50mmØ)G.M.GATE VALVE

24 DOUBLE FLOAT BUCHHOLZ RELAY WITH ALARM & TRIP CONTACTS

23 TOP OIL FILTER VALVE (32mmØ SSF)WITH PLUG

22 DRAIN CUM BOTTOM OIL FILTER VALVE (50mmØ SSF)WITH PLUG

21 JACKING PADS

20 EARTHING BAR WITH PIN TYPE EPOXY INSULATOR SUPP.(50x67thk G.I.FLAT)

19 N.C.T. (CAST RESIN TYPE)

18 SILICA GEL BREATHER WITH OIL SEAL

17 DIAL TYPE MAGNETIC OIL LEVEL GAUGE WITH LOW LEVEL ALARM CONTACT.

16 PRISMATIC OIL LEVEL GAUGE

15 CONSERVATOR WITH LIFTING LUGS,OIL FILLING CAP & DRAIN PLUG

14 RADIATOR VALVES (BUTTERFLY TYPE)

13 P.S. RADIATORS WITH AIR RELEASE PLUG, LIFTING LUG & DRAIN PLUG

12 THERMOMETER POCKET WITH MERCURY IN GLASS BULB THERMOMETER

11 AIR RELEASE PLUG

10 RATING AND DIAGRAM PLATE (HINDI & ENGLISH)

9 EARTHING TERMINALS

8 BASE CHANNEL WITH HAULING HOLE & SKID

7 FLAT ROLLERS (BI-DIRECTIONAL)

6 WARNING PLATE FOR TAP SWITCH

5 TAPING SWITCH HANDLE WITH POSITION INDICATOR & LOCKING DEVICE

4 ADDITIONAL NEUTRAL BUSHING

3 LV BUSDUCT

2 HV CABLE BOX WITH DISCONNECTING CHAMBER

1 TRANSFORMER TANK

SRNO.	DESCRIPTION	QTY

DRN

CHD

APPRD

GENERAL ARRANGEMENT

OF TRANSFORMER



SCALE
1:

REF.JN:

DRG.NO.3GA: -

FOR TENDER PURPOSE ONLY

ASSLY
SALES
COPY TO

8

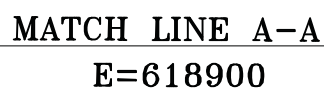
7

6

5

4

SUBMERGENCE OF OMKARSHWAR DAM



-:CO-ORDINATES OF TURNING POINTS:-

S.L. No.	LATITUDE	LONGITUDE
AP-71	22°13'43.1	76°09'10.9
AP-72	22°13'49.0	76°09'20.7
AP-73	22°13'50.5	76°09'48.7
AP-74	22°13'49.7	76°10'07.1
AP-75	22°13'53.0	76°10'10.7

NTPC Limited
GOVERNMENT OF INDIA
ENGINEERING DIVISION

NTPC DRAWING NO.:
0000000000R000Y0000000
SHEET NO.

WING NO.:
0000000000R000V0000000
S0E000

ANNEXURE VI

CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)

Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.		
466	VI	A		III	2.00.00	2 of 2	Exclusions	Bidder understands that Right of Way for all scope outside the plant boundary like Makeup water system, approach road to makeup water pump house, Overhead transmission lines, Effluent disposal, storm water drain disposal, corridor between ash dyke and main plant, corridor between main plant and colony shall be obtained by NTPC and same is excluded from Bidders scope. Kindly confirm. Land acquisition is in Owner's scope for all the facilities of plant. Land acquisition of 25M wide & 2.82KM corridor inside the forest area (consisting of approach road, MuV pipeline & Transmission Lines) and right-of-way for MuV pipeline corridor & Transmission lines are in the scope of Owner.
467	VI	A		I	1.01.00 f)	1 of 9	f) Complete Civil, Structural and Architectural works, including survey, providing construction offices, field laboratory and construction water equipments, construction power distribution from the supply point of Employer, construction / permanent roads, drainage arrangements, fencing / boundary wall around the land boundary. Bidder understands that fencing / boundary wall around the land boundary is excluded from Bidder's scope inline with Section VI, Part A, Subsection III, Terminal points & Exclusions, cl no 2.01.00 h) Boundary Wall and Fencing is excluded from Bidder's scope. However, fencing required inside plant for steel yard, ash silo area, transformer area etc. is in bidder's scope.	

**CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS
FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)**

Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
474	VI	PAR T-B		D - 01 Civil Works	1.01.00	1 of 393	Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and the borelog data is furnished in Annexure 'C'.	Bidder requests Owner to provide the complete Preliminary geotechnical investigation Report including Laboratory test Report (Chemical as well as Physical properties of subsoil & water).	Please refer to amendment being issued for complete field & laboratory tests data.
475	VI	PAR T-B		D - 01 Civil Works	4.03.01	5 of 393	Unless otherwise instructed by the Engineers, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block.	In consideration of the quantum of work, it may not be possible for the Bidder to fulfil the requirement of the specification within the stipulated time. However, Bidder will develop the temporary WBM Roads & temporary Drains within a block /area according to Site requirement to allow for proper drainage and access.	Bidder to comply with the provisions of specifications.
476	VI	PAR T-B		D - 01 Civil Works	4.03.01	5 of 393	Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material.	Bidder requests Customer to arrange for the Permit for Tree cutting from Forest Dept / local Authority as the case may be. However, stacking of the items mentioned in the specification outside the plant boundary if required shall be the in the scope of Customer.	Refer Amendment being issued.
477	VI	PAR T-B		D - 01 Civil Works	4.03.02	7 of 393	All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure	Bidder requests Owner to provide the detail of those drains/channel proposed to be diverted/constructed by the Owner.	Bidder to Refer to Area Drainage study being issued as amendment.

Bid Document No.: CS-9578-001(R)-2
Project: KHARGONE STPP (2X660MW)

Clarification No. - 02 (Doc. No. - CS-9578-001(R)-2-CLRF 02)
Package: EPC PACKAGE

Page No. 13 of 14

**CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS
FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)**

Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
483	VI	PAR T-B		D - 01 Civil Works	5.05.01 18 85.05.01.19	75 of 393	Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm. Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.	Thickness of foundation slab/raft and base slab of all liquid retaining tank /pit & drain shall be as per design requirement.	Bidder to comply to the requirements of Technical Specification.
484	VI	PAR T-B		D - 01 Civil Works	5.05.01 20	75 of 393	All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter.	Bidder envisages suitable paints for corrosion protection of insert plates provided in liquid retaining structure.	Bidder to comply to the requirements of Technical Specification.
485		~~PAR T-B~~		~~D - 01 Civil Works~~	~~5.05.02~~	~~77 of 393~~	Guarantee The Contractor shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later.	Bidder requests to replace 36 months with 18 months.	Bidder to comply to the requirements of Technical Specification.
486	VI	PAR T-B		D - 01 Civil Works	5.10.00	107 of 393	The thickness of side walls and bottom slab of RCC drains shall be minimum 200 mm or as per design considerations whichever is higher. The	Thickness of side wall & bottom of RCC drain shall be as per design requirement.	Please refer Amendment being issued in this regard.
487	VI	~~PAR T-B~~		~~D - 01 Civil Works~~	~~5.11.00~~	~~108 of 393~~	All existing drains crossing the project / site shall be diverted suitably and shall be discharged into a natural drainage outside plant	Bidder consider the scope of diversion of storm water drain upto existing natural drain is limited for plant area only. Hence, Ash pond, township area	Please refer Amendment being issued in this regard.

Bid Document No.: CS-9578-001(R)-2
Project: KHARGONE STPP (2X660MW)

Clarification No. - 02 (Doc. No. - CS-9578-001(R)-2-CLRF 02)
Package: EPC PACKAGE

Page No. 429f

**CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS
FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)**

Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
499	VI	PAR T-B		D - 01 Civil Works	8.01.51	169 of 393	Bituminous Coating The internal surfaces of water retaining structure which are in contact with water shall be applied with two coats of bitumen paint conforming to IS : 9862, at the rate of 1.5 Kg / Sq. M. in first coat and 1.0 Kg / Sq. M. in second coat. Bidder envisage that internal surfaces of CW Basin which are in contact with water shall be applied with two coats of bitumen paint conforming to IS : 9862, at the rate of 1.5 Kg / Sq. M. in first coat and 1.0 Kg / Sq. M. in second coat and not in all water retaining structures. Bidder to refer to amendment being issued.
500	VI	PAR T-B		D - 01 Civil Works	9.10.15	194 of 393	Solvent Based Exterior Paint The paint shall be solvent based (resin based). The coating shall be resistant to alkali, acids, & mould growth. Solvent based paint without resistance to alkali, acids, & mould growth shall be provided by the Bidder as exterior paint. The Exterior Finish Shall be Premium Acrylic Smooth Exterior Paint with silicone additives over suitable primer / water proof cement paint. Refer to amendment being issued.
501	VI	Part - D		ERECTION CONSTRUCTION OF CONTRACT RACT	27.02.00	11 of 53	Water Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony. Bidder request to provide Construction water within Plant Boundary. Otherwise, Owner to allow to install Borewells at different locations inside the Plant Area and Permits for the same from concerned Authorities shall be arranged by NTPC. Bidder to comply the provisions of specifications.
502	VI	PAR T-B		D - 01 Civil Works	5.07.06	87 of 393	Control building, M. C. C. Buildings: All air - conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system (details specified elsewhere) with under deck insulation. Under deck Insulation shall be provided in single storey building below the roof slab in the air - conditioned areas & under the roof slab of top most floor of multi storeyed buildings in the air conditioned area. All Roofs / Terraces of airconditioned spaces which are exposed to atmosphere shall have under deck insulation. Airconditioning design shall be done accordingly.
503	VI	PAR T-B		D - 01 Civil Works	5.33.00	128 of 393	Owner's Construction Office: This building shall be a single storeyed building and shall be provided with floor area of 2800 sq.m. with brick masonry wall and RCC frame structure. Floor to Roof As per RFQ input Drg no. 9578-001(R)-POC-A-006, the Owner Site Office shall be single storeyed pre fabricated detachable portable cabins type construction with roofing of double layer with upper grid having GI Building shall be constructed as per RFQ input Drg no. 9578-001(R)-POC-A-006.

Bid Document No.: CS-9578-001(R)-2
Project: KHARGONE STPP (2X660MW)

Clarification No. - 02 (Doc. No. - CS-9578-001(R)-2-CLRF 02)
Package: EPC PACKAGE

Page No.13of

FOR EPC PACKAGE OF KILARGONE STEEL (2X660MW)

Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
						height shall be minimum 4.25 m. and the design of building shall give emphasis on swift construction of building and architectural character of the building.	Preconstructed . Bidder request Owner to clarify the type of building to be constructed at site Bidder envisage that the Owner Site Camp/Residential infrastructure /Transit Camp are excluded from Bidder scope.		
504	VI	B			6.03.25	142 of 393	Area drainage study report	Customer to provide area drainage study report as indicated in drawing no 9578-001(R)-POC-A-001	Report is being issued as Amendment.
505	VI	B			4.03.01	6 of 393	Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. "9578- 001-POC-A-001.	Bidder request Owner for the soft copy of 9578-001-POC-A-001 .	Bidder to comply the provisions of specifications.
506	VI	B			7.01.0	151 of 393	Owner has carried out preliminary geotechnical investigation in the plant area, pipe line corridor from plant to intake well including crossings (river/nallah/ canal/ road/ railway track etc.) and intake well location of project site and the borelog are enclosed at Annexure-c for Bidder's reference	Bidder requests Owner to provide the complete Preliminary geotechnical investigation Report including Laboratory test Report (Chemical as well as Physical properties of subsoil & water).	Please refer to amendment being issued for complete field & laboratory tests data.
507	VI	B			1.1	1	The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works.	Site laboratory shall be equipped with the facilities to perform routine tests at the site. However any specific test if required shall be done at a mutually acceptable external laboratory. Please confirm	Bidder to comply with specification
508	VI	B			1.1	1	The Bidder shall make the layout and levels of all structures from the general grid of the plot and the	Bidder understand that owner/employer will provide atleast one benchmark & coordinate inside	Details available with the Owner are already provided. However, further Survey of the
Bid Document No.: CS-9578-001(R)-2 Project: KHARGONE STPP (2X660MW)						Clarification No. - 02 (Doc. No. - CS-9578-001(R)-2-CLRF 02) Package: EPC PACKAGE			Page No.13of

**CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS
FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)**

Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
						nearest GSI benchmark or other acceptable benchmark of Govt. dept. As per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.	and outside the plant boundry as well as at intake location .Please confirm	area is in bidder's scope.	
509	VI	B			6.03.02 (m)	134 Of 393	Where Wind is the main Load acting on the Structure, no increase in Stresses is to be considered for Design of Structures and Foundation Bolts.	Bidder intends to increase the stresses as permissible as per Clause 3.9.2.1 of IS800 1984	Bidder to comply with specification
510	VI	B			6.03.03	135 Of 393	Design of steel structures shall be done by the Working stress method. Design shall be as per provisions of IS:800 :1984 and other relevant IS standards.	Bidder intends to design steel structures by Limit state method using IS 800 2007	Bidder to comply with specification
511	VI	B				135 Of 393	Following connections will be provided during erection : 1. Welded connection a) connection of secondary beam to main beam b) connection of bracing to column c) connection of bracing to the longitudinal beam d) connection of longitudinal tie beam to column e) connection of spandrel beam to column f) connection of their secondary structures	Bidder may consider bolted connection also at site. Please confirm	Please refer to Amendment no. 1 issued.

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Sl no	Reference			Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book Sub-sec Clause No. Page no.			
512	VI	B		All buildings, having structural steel frame work shall have non insulated metal cladding on exterior face above the masonry work and RCC roof over permanent metal deck shuttering, except in areas subjected to heavy loads where RCC roofing without metal deck shall be provided. For Mill & bunker buildings and TPs, insulated metal sheeting roof shall be provided.	Bidder envisaged masonry wall cladding in ESP control room. Bidder request Owner to clarify the buildings where non insulated cladding to be provided on the exterior face of the building.	Please refer to amendment being issued.
513	VI	B		All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level.	Water table is not indicated in the bore log data. Please arrange to provide the same.	Water table has been shown in the borelogs of respective areas. Bidder to refer borelogs.
514	VI	B		No foundation shall rest in black cotton soil.	If encountered with black cotton soil, either complete black cotton soil shall be removed or stabilized using appropriate technique	Bidder's understanding is correct.
515	VI	D		Site management during construction phase till handing over of plant.	Bidder may develop the site office and basic Site facilities like Canteen, First Aid Room, Rest Room, etc. of prefab/ pre-engineered / porta cabin by combination of Container type also.	Specification requirement is clear.
516	VI	B		Design consideration for switchyard equipment support	As per this clause "Common raft foundation shall be provided for each	Bidder to comply to the requirements of Technical

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Sl no	Reference						Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.			
517	VI	B		D-01 CIVIL	5.12.02	109 of 393	Road	pole of isolator". Can we design as isolated footing (6 No. of Footings) for isolator.	Specification
518	VI	B		D-01 CIVIL	5.07.04	86 of 393	Crusher house shall be framed structure of steel work	As per this clause "1.5 M wide shoulders on both side of Road for single lane". Can we provide 1.0 M wide shoulders on both side of Road as per NTPC Standard drawing for 3.75 m Road.	All single lane road is to be provided with 1m wide shoulders on both side.
519	VI	A		I	1.01.00	1 of 9	The complete scope of the proposal for the Design, Engineering, Manufacture, Supply, Construction, Erection, Testing & Commissioning works for the Turkey EPC Package for KATWA Super Thermal Power Project (2 x 660 MW), shall be on the basis of single point responsibility, completely covering the following activities and services in respect of all the equipment & works specified and covered under the specifications :	NTPC may accept RCC construction for crusher house building. It will reduce cost considering the size of building which shall be substantial. At least upto crusher level the building can be of RCC and above crusher level it can be of steel. NTPC may confirm.	Provision of clause no. 5.07.04, subsection D-01(civil), Part B of Technical Specifications shall prevail.
520	VI	A		II-A-18	Introdu tion (Solar PV)	1 of 7	The EPC contractor shall design the roofs of various buildings in the thermal power plant so as to maximize the shadow free area on roof-top suitable for installation of	The name of Power project may please be specified as Khargone.	Pl. refer amendment-01 issued in this regard.
								Kindly specify the Appendix Number.	Refer amendment-01 issued in this regard.

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Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.		
							Plant to Discharge Point ii) Geotechnical report at various locations along the proposed route. iii) Details of existing structures fouling with the route. iv) Area drainage study report b) Right of way, land acquisition, statutory approval for road cutting/diversions, blasting (if required), MOEF/CPCB clearance etc. are not included in Bidder's scope. Please confirm that Owner shall arrange the same.	
524	VI	A		IID	1.00.0	1 of 7	Water supply system for the entire plant area including connection to buildings of the Owner (a supply point to be provided near to such buildings). Please provide list of buildings under Owner's scope.	Specification requirement is clear.
525	VI	A		IID	1.00.0	1 of 7	2.82km approach road inside forest area from the nearby existing road up to the river bank for access to the Intake Pump House u/s of Omkareshwar Dam and including all cutting, filling and construction of culverts, diversion of nallah etc. a) Bidder understands that the scope of new road for make-up pipeline corridor is limited to 2.82 km approach road (From CH. 38164 to CH. 40983) starting from nearby existing road up to the river bank. Please confirm. b) Please furnish us the width of the 2.82 km approach road to considered for make up water facilities. c) Is drain required along the 2.82 km road? If yes then whether the drain will be one side or on either side of the road. Please confirm.	Road work from CH. 38164 to CH. 40983.182 is in the scope of the bidder. Single lane rigid pavement road as specified at Cl. 5.12.02 of SUB-SECTION-CIVIL WORKS shall be adopted for approach road to make up water facilities area. Drains wherever required shall be provided to prevent water accumulation, based on actual

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Sl no	Reference			Page no.	Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book Sub-sec	Clause No.			
						d) Right of way, land acquisition, tree cutting, statutory approval for road cutting/diversions, blasting (if required), MOEF/CPCB clearance etc. are not included in Bidder's scope. Please confirm that Owner shall arrange the same.	ground profile. Obtaining Environmental clearance, Right of way, land acquisition, tree cutting (except jungle clearance) for Muw facility area u/s of Omkareshwar Dam and 2.82KM Muw pipe corridor inside the forest area are in the scope of Owner. Rock excavation by blasting will not be permitted for laying of Muw pipeline outside plant boundary and also for Muw facilities u/s of Omkareshwar dam. For scope of all road /rail/river/canal crossings bidder to refer to Clause No. 1.00.0 (8.d) of Sub-Section IID Civil Works Part A of Technical Specifications.
526	VI	B	Civil Works	-	Index	13.00.00 (1) SITE SPECIFIC AREA DRAINAGE STUDY FOR PLANT, ASH DYKE & TOWNSHIP Please furnish the site specific area drainage study for plant.	Roads outside plant boundary is not in bidder's scope.
527	VI	B	Civil Works	4.03.03	7 of 393	Before commencement of cutting/filling, all organic and vegetable matters like grass, plants shrubs bushes, weeds, trees etc. in a) Tree Cutting shall be owner's scope. Owner is requested to confirm. b) If any overhead electric lines are	Refer Amendment being issued.

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Sl no	Reference			Page no.	Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book Sub-sec	Clause No.			
	VI	B	Civil Works	5.04.08.12	73 of 393	Cutting/ filling is required to be carried out within the land acquisition boundary (100M x 75M) on the river/reservoir bank u/s of Omkareshwar dam for make-up water facilities including switchgear room, control room, transformer foundations, 66kV substation etc. for feeding power supply to the intake water pump house. b) Right of way, land acquisition, tree cutting, statutory approval for road cutting/diversions, blasting (if required), MOEF/CPCB clearance etc. are not included in Bidder's scope. Please confirm that Owner shall arrange the same.	b) Obtaining Environmental clearance, Right of way, land acquisition, tree cutting (except jungle clearance) for Muw facility area u/s of Omkareshwar Dam and 2.82Km Muw pipe corridor inside the forest area are in the scope of Owner. Rock excavation by blasting will not be permitted for laying of Muw pipeline outside plant boundary and also for Muw facilities u/s of Omkareshwar dam. For scope of all road /rail/river/ canal crossings bidder to refer to Clause No. 1.00.0 (8.d) of Sub-Section IID Civil Works Part A of Technical Specifications.
531	VI	E	~~Tender Drawing~~	~~Drawn No. IA-12-149~~		Final Effluent discharge line survey drawing Report & a) Please provide the width of all existing Nallans for determination of cross-over lengths. b) Right of way, land acquisition, tree cutting, statutory approval for road cutting/diversions, blasting (if required), MOEF/CPCB clearance etc.	Specification requirement is clear in this regard

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
~~532~~	~~VI~~	~~B~~		~~Civil Works~~	~~5.01.00 a) (i)~~	~~11 of 393~~	~~Confirmed.~~
					The roof truss to column connection shall be bolted connection using high strength bolts (grade 8.8/ IS 1367). The roof truss of Turbine Hall shall be adequately braced in plan using Tie Level and Rafter Level Bracings.	are not included in Bidder's scope. Please confirm that Owner shall arrange the same.	
						Roof system of Main Power House Building is mentioned differently in both the clauses. Based on these two clauses, Bidder shall have the option to adopt roof girder or truss system. Please confirm.	
~~533~~	~~VI~~	~~B~~		~~Civil Works~~	~~5.01.01~~	~~24 of 393~~	~~Confirmed~~
					This building (Service Building) shall be Five storied (Ground +4 stories above) and shall be provided with floor area of 4500 sq.m with RCC framed structure.	Bidder understands 4500 sq.m floor area shall pertain to the total area of all floors in the building. Please confirm.	
~~534~~	~~VI~~	~~B~~		~~Civil Works~~	~~5.04.08 .08~~	~~71 of 393~~	~~Bidder to comply to the requirements of Technical Specification.~~
					The intake water pump house over the intake well shall be of RCC construction upto crane girder level/ bracket level. Above crane girder level/ bracket level, structural steel super structure with trenched permanently colour coated sheet metal cladding shall be provided on exterior face. The sheet metal cladding shall be provided with adequate overlap.	Bidder proposes use of permanently coloured metal sheet for roofing of intake pump house. Please confirm.	
~~535~~	~~VI~~	~~B~~		~~Civil Works~~	~~5.04.08 .09~~	~~71 of 393~~	~~Bidder to comply to the requirements of Technical Specification.~~
					The deck of approach bridge shall be sized for make-up water pipelines, electrical cabling and	a) Bidder proposes use of cast-in-situ RCC deck (Grade M 30) laid over steel longitudinal and cross beams. Please	

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec				Clause No.
					space for movement of equipment required in the pump house. The deck shall be of structural steel.	confirm. B) Please specify the minimum carriage way width required to be kept for the approach bridge in order to facilitate movement of equipment, vehicles etc.	Minimum width of carriage way for the approach bridge (between 2nos. of MuV Pipes) shall be 4.0M. However, higher width of carriage way, if required, for erection/movement of Pump/ motor/ EOT Crane etc. shall be provided by the Bidder at no additional cost to the Owner.	
536	VI	B		Civil Works	5.08.07 105 of 393	RCC stairway type energy dissipation channel at discharge points on the inside slope of ash dyke shall be provided.	Scope of construction of RCC energy dissipation structure at discharge points is excluded from Bidder's scope of work, since Ash Dyke is not in Bidder's scope. Please confirm.	RCC stairway type energy dissipation channel at discharge points on the inside slope of ash dyke shall be provided by the bidder.
537	VI	B		Civil Works	5.08.09 105 of 393	Single lane maintenance / Inspection road with 1.5m wide shoulders on both sides of the road shall be provided along the route of the ash slurry pipeline from plant boundary wall to the ash dyke along ash pipe lines.	a) As per the General Layout Plan road from plant boundary to ash dyke boundary is shown in hatch which is not in bidder's scope. Please confirm.	Roads outside plant boundary unless noted otherwise are not in Bidder's scope.
538	VI	B	1	Tender Drawing	9578-999-POC-F-001	Facilities not in Bidder's scope	b)As per the General Layout Plan, roads shown outside plant boundary along with adjacent drains (shown in Hatch) is not in bidder's scope. Please confirm.	Please refer Amendment being issued in this regard.
				Civil Works	5.11.00 108 of 393	Diversion of Existing Drainage and Discharge of Plant Drainage into Natural Drainage System.	Please furnish us the discharge from Ash Pond and township to be considered for sizing of the final outlet	

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SI no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
						boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical: 2 Horizontal) and provided with good quality dry stone pitching minimum 300mm thick	during wall construction. The other agency shall bring back the original graded / formation level and hand over to the bidder. b) Alternatively, the Owner is requested to construct the plant boundary wall first and then hand over the site for grading.		
546	VI	B		Civil Works	5.01.00 a)	13 of 393	The external vertical face (herein stated as 'C' row) facing (& adjacent to) the Boiler area shall be completely covered upto the Deaerator floor level with vertical cladding comprising 3.0m high brick wall on Ground floor followed by either single skin metal sheeting with runners or brick wall sand wicheed with single skin metal sheeting on external face(for all floors requiring 4 hrs of fire rating eg Cable Spreader room, Ventilation/ Air Washer Room & AHU Rooms)	Owner is requested to clarify clause 5.01.00 a). Bidder understand that wherever there is a requirement of fire rating, single skin metal sheet with brick wall has to be provided. Owner is requested to confirm bidder understanding.	Aluminium Frames shall be used for Glazed Doors, Windows & Ventilators. Bidder's understanding is correct.
547	VI	B		Civil Works	5.01.00 a)	14 of 393	All door, windows in air conditioned area and all windows glazing shall be provided with Aluminum frame work Steel door and Fire Proof doors shall be provided as per requirements.	Aluminium frames with steel doors combination may not be applicable. Owner is requested to clarify the same.	Aluminium frames shall be used for Glazed doors, Windows and Ventilators.
548	VI	B		Civil Works	5.04.01 a)	57 of 393	The pump houses shall be provided with minimum two sets of stop-logs along with electrically operated hoisting arrangements. Steel embedments required for stop-logs	One stop log is required for common sump for the pump house. Please clarify whether one spare stop log is also required. Owner to please confirm.	Bidder to comply to the requirements of Technical Specification

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
559	VI	A		IID	1.00.0(3)	1 of 7	Construction stores (covered) and Open Store Yard with RCC paving & chain link fence and gate.
							~~c) Minimum reinforcement d) Height of Chain link fence.~~ We understand that the construction stores (covered) is a part of EPC Contractor's site establishment facility and hence the size and spec of the building shall be decided by the bidder. Please confirm.
560	VI	A		IID	1.00.0(3)	1 of 7	Sewerage system for the entire plant area and sewage pumping arrangement and connection up to sewage treatment plant, connection of sewage system of all buildings to the nearest manhole (including buildings of Owner).
561							Please furnish us the following: a) List of Owner's buildings. b) No. of toilet to be considered in Owner's buildings.
							Is service road required along the make up water piping from plant boundary upto intake well? If yes then provide necessary details.
562	VI	B		Civil works	5.08.01	104 of 393	The civil works for Ash handling system (both wet and dry) shall comprise of bottom ash and fly ash handling systems, which includes Ash slurry pump house, Ash water pump house, EA slurry pump house and their related sumps/tanks, Transport/Instrument Compressor
							a) Is peripheral drain along ash dyke included in bidder's scope? b) Is peripheral road along ash dyke included in bidder's scope? If yes then please provide brief spec viz. single or double lane, RCC or bitumen etc. c) Is approach road to ash dyke from
							Peripheral drain along ash dyke is not included in bidder's scope b) Peripheral road along ash dyke is not included in bidder's scope c) Approach road to ash dyke

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SI no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				
						masonry wall and RCC frame structure.	portable cabin type construction. Bidder understand that the specification mentioned in the drawing shall be followed. Please confirm bidder's understanding.		
566						General	Area drainage study is excluded from bidder's scope. Please confirm.	~~Bidder's presumption is correct~~	
567	VI	B		Civil works	5.36.00	129 of 393	For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements.	Is loco shed included in bidder's scope. If yes then please furnish us the specification indicating the size, type of building, its location, capacity of crane etc.	~~Loco shed not in bidders scope~~
568	VI	B		Civil works	5.04.08 .12	73 of 393	The FGL of the area shall be 2M above maximum water level of the dam.	The FGL for the make up water facility area shall be 201.62 m i.e. (199.62 + 2). Please confirm.	The FGL for the make up water facility area shall be 201.62 m i.e. (199.62 + 2)
569		B			5.15.00	112 of 393	Data for Design of intake well and approach bridge - Maximum water level - 199.62 M	There are 6 Nos of gates shown in General Layout Plan (Dwg No : 9578-999-POC-F-001) which are as follows : a) Gate No.1 in front of Gate Complex. b) Gate No.2 in front of admin building. c) Gate No.3 at the entry of railway line. d) Gate No.4 at the entry of railway line near green belt area. e) Gate No.5 for ash bunker movement which is inside the plant.	Gates are to be provided as shown in General layout Plan.
	VI	E		Tende		2 of 2	General Layout Plan : 9578-999-		

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Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply
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							parking for staff shall be provided.	cars & 4 trucks shall be provided.
572	VI	E		Tender Drawings			Drg No. 9578-999-POC-F-001, General Layout Plan, Rev. 1	Is dismantling of existing road passing across the raw water reservoir included in bidder's scope of work? Please confirm
573	VI	E		Tender Drawings			Drg No. 9578-999-POC-F-001, General Layout Plan, Rev. 1	Drain diversion corridor within land acquisition line is indicated along periphery of boundary wall. Please furnish the start and end point of diversion drain to be considered by the bidder.
574	VI	B		Civil works	5.04.08.09	71 of 393	The deck of approach bridge shall be sized for make-up water pipelines, electrical cabling and space for movement of equipment required in the pump house.	Please specify the minimum width of the approach bridge for intake well to be considered by the bidder.
575	VI	B		Civil works	5.04.08.00	64 of 393	Intake Water Pump House and Make-up water facilities upstream Omkarneshwar Dam.	Please specify the minimum diameter of intake well to be considered by the bidder.
576	VI	B		Civil works	5.02.02	28 of 393	However, the top few meters of the liner shall be so designed and shall be of such material which shall withstand corrosion due to acid attack/condensation of flue gases.	Please let us know whether we can use mini shell with 115mm thick acid resistant brick lining for liner above roof slab.
577							Site Clearance	Please provide the Existing Structures detail where the rerouting / dismantling work if any for assessing the quantum of work.

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
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						cooling towers each cell shall be provided with a cell isolation valve	
587	VI	B		Sub Sectio n-A-13	3.04.01	23 of 58	FRP stacks for cooling towers are made by hand moulding process only and not by pultrusion. Kindly confirm.
588	VI	B		Sub Sectio n-A-13	3.04.12	26 of 58	Design rating of the gearbox as per DIN standard with service factor of 3.0 over Motor rating. Kindly confirm.
589	VI	B		Sub Sectio n-A-13	3.04.15	26 of 58	Design rating of gearbox shall be Alternate arrangements are also acceptable
596	VI	A		Sub Sectio n-IID	1.00.0 (d)	3 of 7	Bidder to note that obtaining necessary approvals from Railways, NHAI, State WRD, PWD & Irrigation departments etc. for all rail, road, river and canal crossings is in the scope of Bidder. The contractor shall appoint a railway approved consultant for design/execution/supervision of box/pipeline culvert as per requirement/approval of Railways and for obtaining approval from Railways for rail crossing.
591						General	During our site visit it has been observed that existing structures as mentioned below enroute to make up water piping corridor: a) Railway crossings b) Canals
							Bidder to refer Tender Drg. No. 9578-001(R)-PVC-A-004-SH-1 to SH-12.

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-Clause No. Page no.			
592					Preliminary topographic survey of the make up water piping corridor	c) Bridges & Culvert Owner is requested to provide Plan and cross sectional details with dimensions for the existing structures. a) Bidder understand that the topographic survey of the piping corridor and the 2.82 km approach road to make up water piping facilities given in the tender specification is the identified route for intake piping corridor. If there is any change in alignment or location of intake piping and approach road to 2.82 km make up water facilities corridor at a later stage, then same shall be governed under clause 39.2 of GCC (Section IV) i.e. Changes originating from Employer. Owner to please confirm acceptance.	Any deviation w.r.t the pipeline corridor indicated the Tender Drawing shall be governed by provision of Bidding Document.
593	VI	B		Civil works 5.04.08 .05 68 of 393	An intake well shall be founded in the submergence of Omkareshwar	b) Right of way, land acquisition, statutory approval for road cutting/diversions, blasting (if required), MOEF/CPCB clearance etc. are not included in bidder's scope. Please confirm that Owner shall arrange the same.	Obtaining Environmental clearance, Right of way for MUV corridor and land acquisition for MUV facilities u/s of Omkareshwar Dam are in the scope of Owner. For scope of all road /rail/river/ canal crossings bidder to refer to Clause No. 1.00.0 (8.d) of Sub-Section IID Civil Works Part A of Technical Specifications. Feasibility study, Bathymetric survey and Hydrographic

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
						Dam on River Narmada at a location indicated in the Tender Drawing.	survey are not in the scope of the bidder.
						drawing, the following are excluded from bidder's scope of work. Please confirm. a) Feasibility study b) Bathymetric survey c) Hydrographic survey	
594	VI	E		Tender drawings	9578-001(R.) -PVC-A-001	The contour levels at the railway siding area towards the east and green belt portion at south are missing from the tender contour drawing. Owner is requested to furnish the balance contour levels.	Available details are furnished. However, further survey is in Bidder's scope.
595						General	Bidder to refer co-ordinates of boreholes shown in the borelogs.
596	VI	B		Civil works	Annexure (K) ©	Site management during construction, phase till handover of plant - The plant site is fully secured against unauthorized access. For the same he shall take up boundary wall construction immediately after award.	Plant boundary wall is excluded from Bidder's scope.
597	VI	B		Civil works	Annexure (K) (n)	Development of suitable landscape & green belt areas and rainwater harvesting within the plant premises. Bidder shall plan to develop the landscape & green belt areas	Refer amendment being issued in this regard.

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Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
598						393 of 393	~~Provision of adequate shelters, water supply, sanitation and lighting in construction workers and staff camps. No camps for workers and staff shall be permitted within the plant premises and Bidder shall make separate arrangement outside the plant premises for locating and development of camps for construction workers and staff.~~	~~Space for bidder's labour colony, construction offices and other required facilities of bidder is shown within plant boundary as per the general layout plan drawing of tender document section Volume VI, Part E. Owner to please clarify that space for bidder's infrastructure, laydown space and labour colony shall be available within plant premises.~~	~~Refer amendment being issued in this regard.~~
599	VI	B		Civil works	Annexure (K) (c)	72 of 393	(c) Minimum Draw down level : 193.54 M (e) Actual water level (on 13.05.2011) : 188.5 M	The minimum drawl down level of RL 193 m indicated in the specification is above the minimum water level of RL 188.5 m. Please clarify.	One level of opening shall be above the MDDL of dam and the other level of opening shall be provided below MDDL based on the actual submergence level for continuous drawl of water. Bidder to refer Cl. No. 5.04.08.05 of SUB-SECTION-CIVIL WORKS
600	VI	A	-	II.D	1.00.0	5 of 7	18. Civil, Structural, Architectural works for the following Offsite	Any specific requirement of shed for O&M works are not mentioned in	Refer amendment being issued in this regard.
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Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
623	VI	B	4 OF 5	D-01	5.33.00	128 of 393	"This building shall be a single storied building and shall be provided with floor area of 2800 sq.m. with brick masonry wall and RCC frame structure. Floor to Roof height shall be minimum 4.25 m. and the design of building shall give emphasis on swift construction of building and architectural character of the building.	Drawing No. 9579-999-POC-A-006 REV-A states that Owner's Construction Office shall be of <u>pre-fabricated detachable portable cabins</u> . There is mismatch in the type of construction of office. Kindly clarify	Building shall be constructed as per input Drg no. 9578-001(R)-POC-A-006
624	VI	A	-	I-B	Annexure-II	5 of 11	Project information : Climatological data Height above MSL -251 m	Elevation of 254.5 m is to be used for SG and Auxiliaries design. Please confirm.	Finished formation level proposed for the main plant block is RL (+)254. However final level is to be decided by bidder as site levelling is in bidder's scope.
625	VI	E	-	Tender Drawings: 9578-999-POC-F-001			Notes : Elevation 0.00 corresponds to RL (+) 254.5 m	We understand that gate openings for the Intake well are to be between "Maximum water level" and "Minimum level". Please clarify.	The gate openings for the Intake well are to be between "Maximum water level" and "Minimum water level at RL 188.5 m "
626	VI	B	4 OF 5	D-01	5.04.08 .10, b) & d)	72 of 393	b) Maximum water level: 199.62M d) Minimum draw down level : 193.54M	Inside the TG building where the CW pipes are provided below the grade slab, if top of encasement of CW duct can be provided at 1m below grade slab please confirm.	Encasement of CW pipes inside Condensor pit is not envisaged. Top of encasement of CW duct shall be 1.5m below FGL in transformer yard area with grade slab.
627	VI	B	4 OF 5	D-01	5.04.05	60 of 393	C.W. Ducts: CW ducts from C.W. pump house up to condensers and from condensers up to cooling towers shall run through concrete encased steel lined ducts. The concrete encasement shall be of minimum 500mm thick with		

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						trenches supporting pre - cast covers, supported edges of pre - cast cover. Angles 75 x 75 x 6 mm (minimum) with 8mm dia and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs.	
	VI	B	4 OF 5	D-01	8.01.07	165 of 393	
						1000mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.	
665	VI	B	4 OF 5	D-01	8.01.33	167 OF 393	
	VI	B	4 OF 5	D-01	9.04.19 (b)	187 OF 393	In view of contradictory clauses, it is proposed to give 750 mm wide plinth protection around all buildings. It consists of 50 mm thick P.C.C. M-15 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size. Please confirm.
						750 mm wide plinth protection around all buildings other than those covered under paved area.	750 mm wide plinth protection around all buildings shall be provided. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size.
	VI	B	4 OF 5	D-01	5.07.14	93 OF 393	
						All buildings (including wagon tippler complex, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade	
666	VI	B	4 OF 5	D-01	5.15.00	112 OF 393	The total covered area for all floors and amenities of complete CISF building complex shall be 700 sqm. Please confirm.
						The CISF Building shall be 2-storied building. It shall be of RCC Frame structure & Brick masonry. The floor area of this building shall be minimum 700 sq m....	Confirmed.
667	VI	B	4 OF 5	D-01	5.15.00	112 OF 393	Please provide the requirement including number of vehicles and area for parking space for open and covered parking for staff. Further it is understood that only the space for the subject parking is to be provided, not parking facility and
						In addition, provision for space for open parking (for trucks, cars, scooters, cycles) and covered parking for staff shall be provided	Covered Parking Shed for 10 cars & 20 scooters shall be provided. Open parking for 10 cars & 4 trucks shall be provided. Parking Facility & related construction are in Bidder's scope.

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Sl no.	Reference				Specification Requirement	Bidder's Query	NTPC Reply
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672	VI	A		II-D	1.00.0 (3)	1 OF 7	Bidder to refer Tender Drg. No. 9578-001(R)-PVC-A-004-SH-1 & SH-2.
673	VI	B	4 OF 5	D-01	5.15.00	111 OF 393	Specification requirement is clear in this regard.
673	VI	B	4 OF 5	D-01			
674	VI	B	4 OF 5	D-01	5.04.08 13	73 OF 393	
					provision of operable galvanized steel grating covers at about 4.0 metre intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. All drains in the main plant area shall be provided with heavy duty galvanized steel grating.		
					2.82km approach road inside forest area from the nearby existing road up to the river bank for access to the Intake Pump House u/s of Omkareshwar Dam and including all cutting, filling and construction of culverts, diversion of naallah etc.	Kindly furnish us with layout details and topographical survey along the subject 2.82km approach road inside forest area from the nearby existing road up to the river bank for access to the Intake Pump House.	
					The Gate Complex shall comprise two (2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates.	Bidders understanding for Size for security room is 3mx2m with 3.0m height. Please confirm.	
					The load of cable trays for design purpose.	In absence of load value mentioned in specification, for design purpose the load of cable shall be taken as 80 kg/m for each cable tray of width 600mm.	Bidder's consideration is acceptable
					Bank protection shall be carried out along the bank of reservoir for the length of the land acquired for Make-up water facilities. The	Approximate extent of land acquired and height up to which, bank protection is required may be furnished. NTPC may provide a clear	For area of land acquisition for MuW facility area, Bidder to refer Tender Drg. No. 9578-001(R)-PVC-A-004-SH-1.

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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply		
	Sec	Part	Book	Sub-sec				Clause No.	Page no.
675	VI	B	4 OF 5	D-01	5.09.00	107 OF 393	Sewage treatment plant is to be provided by the Bidder. Bidder shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Service building, Administration building and Canteen building shall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building, with a minimum Three (3) star rating.	corridor for road and as necessary environmental and other statutory clearances for cutting of river bank's natural profile, trees, etc may be required. Please clarify if STP is to be provided for sewage discharge of plant only or discharge of township will also be included in the influent for STP and the associated piping.	Land acquisition and tree cutting of Muvv facility area u/s of Omkareshwar Dam are in the scope of Owner. Environmental and other statutory clearances for MUV facilities area are in the scope of the owner. Sewage Treatment of only plant is in bidder's scope.
676	VI	B	4 OF 5	D-01	5.00.01 (i)	9 OF 393	Since GRIHA rating is applicable to building with sizes greater than 2500m², therefore the proposed canteen building is not eligible for GRIHA rating. Site selection, preserving & protecting landscape, Soil conservation, design to include existing site features may not be applicable with grading and leveling as per NGL & FGL as required during registration. All material & design will be based on Energy modelling simulation.	GRIHA rating is applicable for buildings smaller than area 2500 sq m in industrial complexes. Preservation and protection of existing soil and landscape shall be done to the maximum extent considering the site levelling & grading. For building design and material selection energy modelling is	

GRIHA rating is applicable for buildings smaller than area 2500 sq m in industrial complexes. Preservation and protection of existing soil and landscape shall be done to the maximum extent considering the site levelling & grading. For building design and material selection energy modelling may be used.

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Sl no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
681	VI	B	4 OF 5	D-01	4.03.07	7 OF 393	any coarse grained or fine grained low plastic soil	Earth mixed with gravels/cobbles or morum can be used to the required degree of compaction.	Yes is can be used.
682	VI	B	4 OF 5	D-01	5.01.00 (ii)-c foundation for TG/BFP P/PA/F D/D Alt-II- Rigid	20 OF 393	The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid.	Rigid foundation under operation for TG, BFP, ID, Mills are available for more than one year for 250MW units. Plants are under commissioning for 600MW & construction for 800MW. Rigid foundation is a proven concept.	The provisions of bidding document is clear
683	VI	B	4 OF 5	D-01	5.04.08	7 OF 393	Intake well at Omkarneshwar Dam	Depth of intake well below bottom surface of river may be furnished.	Bidder to refer to cl no. 5.04.08 pg 65 of 393 and cl no 17.06-00 pg 157 of 393 D-01 - Civil works
684	VI	B	4 OF 5	D-01	5.04.02	57 OF 393	The CW pump house shall be open to sky.	By this bidder understands open pump house without columns, side cladding and roof with gantry crane for equipment handling. Kerb shall be provided all around the RCC floor area above FFL.	Kerb walls or handrails shall be provided above FFL of open pump houses
685	VI	B	4 OF 5	D-01	4.03.00	7 OF 393	compaction of 95% or more of Standard proctor density....	1. Earth filling in areas of laydown, vacant areas outside main plant area/ buildings/ cooling tower, auxiliary buildings be compacted to 90% of standard proctor density. 2. Earth filling in areas of Green belt, landscaping, to be compacted up to 85% of Standard Proctor density.	All the areas envisaged for site levelling should be compacted to 95% of standard proctor density.

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SI no	Reference					Specification Requirement	Bidder's Query	NTPC Reply	
	Sec	Part	Book	Sub-sec	Clause No.				Page no.
686	VI	A		II-D	1.00.0 (3)	20 OF 393	Plant storm water drainage inside the plant boundary and disposal outside the plant in the natural drain (Osai River located 3.5km(approx.)from plant boundary)	3. arth filling with cohesion less soil to be done up to 80% of relative density. Route of storm water discharge line up to the discharge point along with route survey and geo-technical investigation may please be furnished. Also note that any maintenance road or fencing works etc is not in bidder's scope along the same.	Refer amendment being issued in this regard.
687	VI	B	4 OF 5	D-01	1A-12-149 (effluent discharge pipeline)	133 of 136	 • Scope of work for the subject pipeline is not clear. • Correlation of pipeline layout w.r.t plot plan is not clear • That does OGL stands for	Spec. requirement is clear in bid documents.	
688	VI	B	4 OF 5	D-01	5.01.00 a (ii)	12 of 393	Minimum gusset plate thickness for bracings shall be 12mm.	Minimum gusset plate thickness for bracings shall be as per design or 10 mm whichever is maximum in all the structures in general, wherever applicable.	Bidder to comply with specification.
689	VI	B	4 OF 5	D-01	5.02.02 - Foundation	29 of 393	The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall not be less than 25mm.	The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall be as per design requirement. However the spacing of radial steel at the outer edge of the foundation shall not be more than 250mm. Please confirm.	Bidder to comply to the requirements of Technical Specification.

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	Sec	Part	Book	Sub-sec				Clause No.	Page no.
690	VI	B	4 OF 5	D-01	5.04.05	60 OF 393	CW ducts from C.W. pump house up to condensers and from condensers up to cooling towers shall run through concrete encased steel lined ducts. The concrete encasement shall be of minimum 500mm thick with square shape outside.	Concrete encasing for CW ducts shall be provided only at turnings and road crossings only. CW ducts in other areas shall be buried. Please confirm.	~~Bidder to comply to the requirements of technical specification.~~
691	VI	B	4 OF 5	D-01	5.05.01 .17	75 OF 393	Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.	For bottom reinforcement, minimum tensile reinforcement in each direction shall be 0.17 % of c/s area as per IS code. However for top reinf. ,0.17 % of minimum steel shall be provided only if there is tension in top surface of foundation, in other cases, where there is no tension in top surface, minimum top tensile reinforcement in each direction shall be 0.12 % of c/s area.	Bidder to comply with specification.
692	VI	B	4 OF 5	D-01	6.02.02 v(b)	132 OF 393	Flat Roofs (where equipment are located) 0.50 T/m2	In case Roof accommodating solar PV, live load 0.50 T/m2 is deemed to include equipment load of the panels and their supporting arrangement. Please confirm.	In case equipment load data is furnished, the flat roof shall be designed for equipment load or 0.50T/m2 whichever is higher.
693	VI	B	4 OF 5	D-01	5.26.00	127 OF 393	provided with interlocking concrete block paving with RCC concrete blocks of minimum M 35 grade.....	For interlocking concrete block paving M35 is exorbitantly high grade, instead M25 shall be used. Please confirm.	The recommended grade designation of paving blocks is as per Table 1 of IS: 15658 is M35 corresponding to light traffic category. Accordingly minimum grade of M35 concrete for paving blocks have been specified. The provisions of bidding document shall prevail.
694	VI	B	4 OF	D-01	5.04.08 .01	64 OF 393	approach road up to the facilities at river bank	Route of approach road up to the facilities at river bank from existing	For MuW Pipeline corridor, refer Tender Drg. No 9578-
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			5			from existing road	road along with route survey and geo-technical investigation may please be furnished.	001(R)-PVC-A-004-SH-1 to SH-12. For geotechnical information refer bore log data already furnished in the Civil Specification	
695	VI	B	4 OF 5	D-01	5.07.14	92 OF 393	Plinth level of all buildings shall be kept at least 500 mm above the finished grade / formation level.	By plinth level bidder understands the FGL which should be kept at least 500 mm above the finished grade / formation level. However, Plinth beam level of all buildings shall be kept suitably below the finished grade / formation level to maintain functional requirement, and soil confinement below grade slab. Please confirm.	FFL (Finished Floor Level) shall be kept 500 mm above finished grade/formation level.
696	VI	B	4 OF 5	D-01	8.02.00 (e) Placing of concrete	171 OF 393	Base Raft and top deck of machine foundations shall be cast in a single pour.	Top deck of machine foundations shall be cast in a single pour. However, Base Raft of machine foundations, due to huge concreting, shall be cast in a suitable number of pours. Please confirm.	Provisions of bidding document shall prevail.
697	VI	B	4 OF 5	D-01	9.11.08	195 OF 393	All windows and ventilators on ground floor of all buildings shall be provided with suitable aluminum grill.	Mention buildings for which all windows and ventilators on ground floor shall be provided with suitable aluminum grill.	As mentioned in the civil specs, all windows and ventilators on ground floor of all buildings shall have aluminum grill.
698	VI	B	4 OF 5	D-01	8.04.00	172 OF 393	Fencing with gate shall be provided around transformer yard, switchyard area, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.	Bidder proposes removable type fencing at withdrawal locations.	Fencing provided should be permanent in nature.
699	VI	B	4 OF 5	D-01	DRG NO.95 78-		Section A-A or A'-A'	As per section A-A or A'-A', only inside road along boundary wall is in bidders scope.	Roads which are not in the scope of bidder are marked in General Layout Plan.
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Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
					399-POC-F-001		
						Boundary wall and outside patrol road is not under bidder's scope. Please confirm.	
762	VI	A		II-D	1.00.0 8(d)	3 OF 7	Laying of make-up Water pipeline from Intake Water Pump House to Raw Water Reservoir including crossings across rivers, railway line, NH/SH/Pucca roads/ village road crossing, canals, drains/nallahs etc.
						By this bidders understanding is that maintenance road along the pipeline or any other facility like fencing etc. is not in bidders scope.	Maintenance road along MUW pipeline is not envisaged. Other facilities shall be as per provisions of the bidding documents (Roads which are not in the scope of bidder are marked in General Layout Plan.)
761	VI	A		II-D	1.00.00 (3)	1 OF 7	All roads within land acquisition line for the plant including access roads to buildings/ structures (including buildings/ structures of Owner), patrol roads along boundary wall (for both inside and outside plant boundary wall)
					DRG NO.9578-989-POC-F-001		Drawing legend no. 9
	VI	B	4 OF 5	D-01	5.01.00 a(ii)	12 OF 393	The base plates of Main Columns in A, B, & C rows shall be grillage type of minimum depth 800mm and comprising bottom base plate, top cap plate & interconnecting vertical stiffeners.
760	VI	B	4 OF 5	D-01	5.01.00 a(ii)	12 OF 393	Bidder proposes base plate without top cap, comprising bottom base plate and vertical stiffeners for all the structures which shall fulfill all design requirement.
							Bidder to comply with specification

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					DESIGN OF STRUCTURES AND EQUIPMENT		factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of -VB/ VB. However, no reduction is permitted if -VB is less than VB.		
708	VI	B	4 OF 5	D-01	Annexure-D1	365 OF 393	Notwithstanding the values of the above mentioned parameters, the design wind pressure so computed at any point shall not be taken less than 1500 N/Sq. meter for all classes of structures, i.e. A, B & C, as defined in IS: 875 (Part-3).	As per basic wind speed of the subject location (39m/sec), and other wind load calculation parameters as per IS: 875 (Part-3), pressure at 10m level comes out to be 900 N/sqm. Therefore application of minimum 1500 N/Sq. meter for all classes of structures, i.e. A, B & C would be significant overestimation. Therefore wind load shall be applied as per IS: 875 (Part-3). Please confirm.	Bidder to comply to the requirements of Technical Specification.
709	VI	B	4 OF 5	D-01	8.01.28	167 OF 393	All foundations and surfaces of substructures coming in contact with earth shall be applied with three coats of hot applied industrial bitumen conforming to IS : 702 (latest), of Grade 85 / 25, at the rate 1.7 Kg / Sq.m / coat.	All foundations of MPH, Boiler, Mill building, chimney, cooling tower and surfaces of substructures coming in contact with earth shall be applied with two coats of hot applied industrial bitumen conforming to IS : 702 (latest), of Grade 85 / 25, at the rate 1.7 Kg / Sq.m / coat. Foundations of pipe racks, pedestals, cable trenches, drains, duct pedestals and other single storey buildings shall not be coated with bitumen.	Bidder to comply with specification
710	VI	A		II-D	1.00.0 (3)	1 OF 7	2.82km approach road inside forest area from the nearby existing road up to the river bank for access to	Kindly furnish us with layout details and topographical survey along the subject 2.82km approach road inside	Bidder to refer Tender Drg. No. 9578-001(R)-PVC-A-004-SH-1 & SH-2.
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	Sec	Part	Book	Sub-sec	Clause No.	Page no.			
							the Intake Pump House u/s of Ormkarshwar Dam and including all cutting, filling and construction of culverts, diversion of nallah etc.	forest area from the nearby existing road up to the river bank for access to the Intake Pump House.	
711	VI	B	4 OF 5	D-01	5.00.01	8 OF 393	The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through.	Kindly mention the time span for 3-D model/walkthrough.	3-D Modelling /Walkthrough is removed from Bidder's Scope. Please refer to amendment being issued.
712	VI	B	4 OF 5	D-01	5.10.00	107 OF 393	Plant storm water drain shall be designed taking into account the finished ground levels of the plant area, drainage pattern, intensity of rainfall, etc with a return period of 50 years.	In absence of rainfall data, as per Isopluvial maps of IMD for Khargone site, value for 50 year return period(24hours) is taken as 300mm/day. IMD formula $P=P_{24}(\frac{t}{24})^{1/3}$. Where, P _t is the required rainfall depth in mm at t-hr duration, P ₂₄ is the daily rainfall in mm and t is the duration of rainfall for which the rainfall depth is required in hr, is used. Using the above formula, hourly rainfall for 50 year return period is found to be 104mm/hr. Kindly confirm.	Refer Area Drainage Study report being issued as amendment in this regard.
713	VI	B	4 OF 5	D-01	Annexure-C	234-363/393	Bore hole data	In the borehole data reduced level of ground level is not mentioned. Please furnish the same.	Bidder to refer to ammendment being issued.
714	VI	B	4 OF 5	D-01	7.02.02-f	152 of 393	During design the Allowable Bearing pressure shall be adopted after approval of detailed Geotechnical investigation report. The maximum allowable bearing pressure in rocky strata shall be as per report and shall be limited to	Allowable Bearing pressure shall be adopted as per approved detailed Geotechnical investigation report instead of limiting to the values as per table-1. Please confirm.	Bidder to comply with the provisions of bid document.
Bid Document No.: CS-9578-001(R)-2 Project: KHARGONE STPP (2X660MW)									
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Project: KHARGONE STPP (2X660MW)

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**CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS
FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)**

Sl no	Reference				Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.	Page no.	
						the values as furnished Table-1	
715	VI	B	4 OF 5	D-01	7.02.02-f	153 of 393	Table-1
						Founding depth mentioned in the table -1 is corresponding to type of soil/rock without consideration of shear strength of soil/rock. For example in BH-39 near Foam PH, up to 5m below NGL net allowable bearing capacity is 12t/sqm as per specification in spite of dense/very dense strata encountered as per bore log. Please review the same. It is requested that founding depth shall be considered as per approved geotechnical investigation report without limiting the founding depth mentioned in the table-1. Please confirm.	Bidder to refer to Amendment being issued
716	VI	B	4 OF 5	D-01	7.02.02-f	153 of 393	Refer in Table-1, founding depth in rocky strata as mentioned that 1m/1.2m embedment in rock with core recovery greater than 20%
						Can the foundation be Founded (placed) on silty sand/ silty sand mixed with boulders/completely weathered rock/rocky stratum with core recovery less than 20%. If founded, can the net SBC as per approved Geotechnical investigation report. For example in BH-31 near chimney area, the depth of foundation of chimney will be 11.5m below NGL (for net Allowable bearing capacity 55 t/sqm) as per the specification which is 8.5m inside weathered/basalt. Please review the same as above stated bearing capacity can be obtained at shallower depth as per relevant IS code recommendations. Please confirm.	Bidder to refer to Amendment being issued.

CLARIFICATIONS NO-02 TO TECHNICAL SPECIFICATIONS FOR EPC PACKAGE OF KHARGONE STPP (2X660MW)

SI no	Reference					Specification Requirement	Bidder's Query	NTPC Reply
	Sec	Part	Book	Sub-sec	Clause No.			
						documents however bidder has an option to develop his own layout keeping the location/orientation of the main power block, power evacuation corridor, make-up water corridor, Ash dyke and the same to be clearly brought out in the bid.	side of cooling towers. However it can be modified as per layout requirement. Please confirm.	needs to be retained as per note no. 2 of General Layout Plan.
						Note 2.		
	VI	E	-		Dwg. No.: 9578-999-POC-F-001	The layout as shown is suggestive and same is to be further developed by Bidder, subject to approval by Owner at detail engg. Stage. However, Owner intends to retain the location of township, <u>reservoir</u> , Ash Pond and railway siding as shown in the drawing.		
747	VI	E	-		Drg. No. 9578-999-POC-F-001 Rev. (GENERAL LAYOUT PLAN)	Entry of Make-up water pipeline in Plant Boundary just above N2439600 (between N2439600 and N2439800)	However, as per "Preliminary Topographical Survey of the make-up water pipeline corridor" (Drg. No. CCCF/NTPC/TS/12/2112) (NTPC drg. No. is not clear) (PDF file page no. 35 of 136)], the make-up water pipeline is entering plant between N2439200 and N2439400.	The entry of MuW pipeline to the plant shall be as indicated in the Tender Drg. No. 9578-999-POC-F-001 titled "GENERAL LAYOUT PLAN".
748					Drg. No. IA-12-149 (Surveyed by Sallies Consultants)	Survey work for Effluent Discharge Pipeline for Proposed STPP	We understand that OGL (41.0m to 102.0m) mentioned is with respect to plant FGL.	Specification requirement is clear
749						Technical report by Sallies Consultants Situation : Start point approximately 1.5 km from Selda, near a lake at L/s. Length : 6976.357 Mtr. Long	Please confirm whether bidder to consider final effluent discharge line as 7 km OR 6.976357+1.5=8.476357 km.	7.0 km length indicated in sub-sec III is approved in the length indicated in survey report shall be considered

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9.10.15	EXTERIOR PAINTING ON WALL (PREMIUM ACRYLIC SMOOTH EXTERIOR PAINT WITH SILICONE ADDITIVES) The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge. Preparation of Surface For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced. Application of Base Coat Base coat shall be of <u>water proofing cement paint</u>. Preparation of Mix for Base Coat Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously. The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere. Application of Base Coat The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.		
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Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scraping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Application of exterior paint

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

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7.00.0	FOUNDATION SYSTEM AND GEOTECHNICAL INVESTIGATION
7.01.0	Soil Data Owner has carried out preliminary geotechnical investigation in the plant area, pipe line corridor from plant to intake well including crossings (river/ nallah/ canal/ road/ railway track etc.) and intake well location of project site and the borelog and lab test results are enclosed at Annexure-c for Bidder's reference. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The preliminary geotechnical investigation report shall be made available for the Bidder's study at the Owner's office, if required.
7.01.02	Contractor shall carry out detailed geotechnical investigation for structures under his scope as per scheme given at Annexure-1
7.01.03	The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundations and allowable bearing pressure/pile capacity for various structures/facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundations.
7.01.04	Tank Foundations a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil. b) Entire expansive soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III. c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers etc to achieve a relative density of not less than 80%. d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.
7.02.00	Foundation System The requirements for the foundation system to be adopted are as given in subsequent clauses.
7.02.01	General Requirements a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations. b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drain and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil. If the encountered sub-strata is black cotton soil, the same shall be either replaced upto the full depth or black cotton soil shall be stabilized by suitable treatment. c) No other foundation shall rest on the filled up ground / soil.
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- d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level.
- e) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.
- f) Foundation for equipments on ground floor

For equipments of static weight upto 1.5T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab may be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensly below the equipment shall be limited to 5T/m². Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5T, the equipment foundation shall be taken to below the Natural Ground Level (NGL) or built up with PCC upto the specified level as per functional requirement. The equipment foundation shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment foundation for the full depth of the floor slab. However, in no case, the foundation depth shall be less than 1.0 m.

7.02.02

Open Foundations

In case open foundations are adopted, following shall be adhered to.

- a) The minimum width of foundation shall be 1.0 m.
- b) Minimum depth of foundation shall be 1.0m below Ground Level.
- c) It shall be ensured that all foundations of a particular structure/ buildings facility shall rest on one bearing stratum.
- d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC up to designed foundation level.
- e) No foundation shall rest in black cotton soil.
- f) During design the Allowable Bearing Pressure shall be adopted after approval of detailed geotechnical investigation report. However, the maximum allowable bearing pressure shall be as per approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure	
	T/m ²	Rafts (width isolated and combine d footings > 6m)

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	width upto 6.0 m	
1m below NGL in Silty Sand / Sandy Silty Clay	8.0	10.0
2m below NGL in Silty Sand / Sandy Silty Clay	12.0	15.0
3m below NGL in Silty Sand / Sandy Silty Clay	15.0	18.0
4m below NGL in Silty Sand / Sandy Silty Clay	18.0	20.0
0.30m Embedment in silty sand with boulders	25.0	25.0
0.60m Embedment in silty sand boulders/completely weathered rock.	30.0	35.0
1.00m Embedment in completely weathered rock/fractured rock/weathered Basalt.	45.0	45.0
1.20m Embedment in completely weathered rock/fractured rock/weathered Basalt.	55.0	55.0

In case any loose/soft pockets in rocky strata is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

g) For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (<u>BTG Area Footings except ESP Footings</u>)	25 mm
Isolated & Strip (<u>Other than BTG Area</u>)	40 mm
Raft (<u>ESP Foundations and other Offsite Structures Footings</u>)	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

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7.02.03

Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

The piling work in river/water body shall be carried out with temporary or permanent MS liner and approved construction methodology. If piles are extending, above bed level of river/water body, in water, permanent MS liner of minimum 8mm thickness shall be provided

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
	600	140
	760	250
Bored cast-in-situ pile	1000	310
	1200	375

Cut Off Level (COL) is considered as 3.0 m below Finished Ground Level (FGL)

Termination criteria of piles shall be as per the approved geotechnical investigation report.

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight/shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 2 Nos. in each mode.

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	Uplift vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (Initial test) the method of loading shall be cyclic as per IS:2911 (relevant part). viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable dewatering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter. ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under : i) Vertical : 0.5% of the total number of piles provided. ii) Lateral : 0.5% of the total number of piles provided. x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer. xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required. xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm. xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge. xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM. xv) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with the beams at pile cut off level in both directions xvi) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.
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xvii) Reinforcement for job piles shall be designed for the allowable safe pile capacities with combinations i.e. compression+bending case or tension+bending case, irrespective of the actual load on each job pile.

7.03.00

Special Requirements

7.03.01

Chemicals in subsoil, as observed during preliminary geotechnical investigation are:

Chemica I	SO ₂ (%)	Chlorides	pH
Sub-soil	0.0091- 0.0880	0.022- 0.040	6.75- 7.03

The above values are for information, however, details of treatment for foundations / underground structures required to counteract soil / water chemical environment, cement type, grade of concrete, type of reinforcement, cover to reinforcement and protective coating to foundations, etc. shall be as per detailed geotechnical investigation to be carried out by bidder. Bidder shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00

Excavation, Filling and Dewatering

7.04.01

For the work of excavation in rock, the excavation shall be carried out by mechanical means and or controlled blasting. Contractor shall engage specialised agency having experience of excavation in rock by mechanical means and or controlled blasting.

Blasting shall be resorted to only with the written permission of the Engineer. All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards etc. pertaining to the acquisition, transport, storage, handling and use of explosives etc. shall be strictly followed.

The contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per Explosives Act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive materials.

Surplus excavated materials shall be disposed off by the contractor.

7.04.02

For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

7.04.03

Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M 7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.04

Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non cohesive soils. In any case, black cotton soil shall not be used in back filling without

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7.04.05	providing cushion of 1m of non expansive cohesive soil/moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.4m moorum shall be provided. The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.
7.04.06	CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.
7.05.00	Sheeting & Shoring The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation, executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.
7.06.00	Special requirements for river side/submergence facilities Bidder may provide suitable foundations as per IRC. The design of river/water body side foundations shall account for local scour around foundations, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC. <u>During design the Allowable Bearing Pressure/pile capacity shall be adopted after approval of detailed geotechnical investigation report.</u> A) Bridge/ Approach bridge piles (Incase pile foundations are to be adopted) i) The design of river/water body side piles shall account for local scour around pile, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC. ii) Contribution of frictional resistance from bed level upto maximum scour depth shall not be considered for computation of frictional resistance of river/water body side piles. iii) All piles shall be located using Total Station Laser Operated Instrument. iii) Initial pile load test under vertical (compression) & lateral loads shall be conducted on initial test piles installed river/water body side. If it is not feasible, initial load tests in simulated conditions (removal of skin friction from pile out of level to the river bed level) may be conducted on river/water body bank with the approval of the Engineer. iv) All the river/water body work safety norms shall be adhered to. v) Diameter of piles for bridge/ approach bridges shall be 1200mm. The vertical capacity, uplift & lateral load carrying capacity shall be as per clause no. 7.02.03. B) For Intake well The termination of river intake well shall be decided based on the following criterion : a) Depth of sinking of well into soil/rock shall be as per IRC-78 considering, scour depth, overall long term safety and stability of intake well. b) In case of well foundation (caissons resting on rock), the stipulations of IRC-78 shall be complied to.
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7.07.00.00

ANNEXURE-I

7.07.00.00

Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00

Scheme of geotechnical Investigation

7.07.02.01

Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Cyclic Plate Load Test (CPLT), Electrical Resistivity Test (ERT), Seismic Refraction Test (SRT) or Cross Hole Test, Pressure Meter Test (PMT), in situ field permeability tests, collection of water samples, etc.

7.07.02.02

The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum.

7.07.02.03

The minimum tests are indicated in **Appendix A**. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT 'N' value in the strata is above 50.

7.07.02.04

Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05

Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

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On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03.00

Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. Gengrs Geotechnica Pvt. Ltd, New Delhi
3. DBM Geotechnics & Constructions Pvt. Ltd, Mumbai
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Consulting Engineers Group Ltd, Jaipur
7. KCT Consultancy Services, Ahmedabad
8. Sohams Foundation Engineering Pvt Ltd, Navi Mumbai

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APPENDIX - A

- i) In Plant Area
a) Boreholes

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main Plant structures (Transformer Yard, Main power house, Boiler, ESP, Chimney, Mills, Fans etc)	40 to 50 m along the rows of main power house columns. Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 3 boreholes under Chimney, Minimum 2 boreholes under each TG, ESP Control Room, TPs.	Depth of boreholes shall be 20m to 25m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with R&D > 50% whichever is earlier.
2	Switch yard area	Minimum 6 no of boreholes	10 to 15 m	
3	Water Treatment plant area	Minimum 5 no of boreholes	10 to 15m	
4	Cooling towers	Minimum 3 boreholes under each cooling tower	15 to 20 m	
5	CW Pump House Area	Minimum 3 boreholes	15 to 20 m	
6	Coal handling area	Minimum one borehole under each TP and one under each crusher house. 2 boreholes under track hopper and wagon tippler and one borehole under each structure. Minimum 3	25 to 30 m	

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		Nos. of boreholes in each Coal Stock Pile area.		
7	Raw Water Reservoir Area	Minimum 5 boreholes	10 to 15 m	
8	Asn Handling Structures	Minimum 5 boreholes	10 to 15 m	
9	Corridors for Ash pipe routes	One borehole @ 750 m c/c along the identified corridor	5 m	
10	Crossings along the pipeline corridor like road, river, nallah/ canal	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10.0m	15 to 20m	
11	Transmission line from Plant to Intake Pump House	One borehole @ 750 m c/c along the identified corridor	10 to 15 m	
12	Other Off site Structure/Facility	Minimum Two boreholes under each area / facility	15 to 20 m	
b) Other Field Tests (Minimum)				
1	Plate Load Test (PLT)	1 no each in ESP, transformer yard area and other area, where open foundations are feasible.	Test Depth from 2 to 4 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, Mill and ID fans	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 20 Nos.	Depth - 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 10 Nos. of boreholes in plant, 4 Nos. of boreholes in Raw Water Reservoir and 8 Nos. of boreholes in ash disposal area	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
5	DCPT	About 10-20% of		

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		boreholes up to refusal depth		
6	ERT	2 Nos. each in Transformer yard, TG, Boiler, Chimney, water treatment plant area, ESP Control Room, 6 Nos. in switchyard, CHP area		
		1 No near each Pump House other than mentioned above		
7	SRT	In Grd covering the Main Power Block from Chimney to Transformer Yard (about 2000 to 2200 m)		
8	PMT	50 no of tests in main power house area covering power house to chimney, TP/Crusher Houses.	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, SRT, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work

Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried

ii) At Intake location in river/water body and make up water pipe line corridor

S.No	Structure	Tests
1	Intake well (river side / water body)	Three boreholes along periphery and One borehole at centre of the Intake well Depth of borehole shall be i) 1.5 times the dia / width of intake well below the founding depth of intake well.

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		ii) 5 m into rock with RQD $\geq$ 50% continuously Whichever above occurs earlier.
2	Bridge/ Approach bridge (river side / water body)	One borehole at 100 - 150m c/c distance along proposed approach bridge / walkway or at each pier location. Depth of borehole shall be i) 50 m below river bed level ii) 5 m into rock with RQD $\geq$ 50% continuously Whichever above occurs earlier.
3	Control room building, swgr room etc. (river bank/ water body)	Three boreholes, two ERT and one PLT Depth of borehole shall be 30m or 5 m into rock with RQD $\geq$ 50% continuously, whichever occurs earlier.
4	Approach road to make-up water facilities from nearby existing road and road all round the make-up water facilities within land acquisition boundary and approach to various buildings.	Field CBR test (California Bearing Ratio) at 750m c/c
5	Bank protection works	Two boreholes along the bank. Depth of borehole shall be 10m
6	Makeup water pipeline corridor	Disturbed samples shall be collected at atleast five locations along the bank, from the surface of the bank to the river bed at 3 metre depth interval. Boreholes of 10 m depth shall be carried out along the corridor @ 750m c/c and one ERT shall be conducted near to each borehole

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7	Crossings along the pipeline corridor like road, river, nallah	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10m Depth of borehole shall be 25m or 5 m into rock with RQD $\geq$ 50% continuously, whichever occurs earlier.

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	Sec	Part	Book	Sub-sec	Clause No.	Page no.	Para Line no.
90.	VI	B	4 of 5	D-01	12.00.00 (d)	365 of 393	2
91.		B	4 of 5	D-01	6.03.07	136 of 393	2
92.		B	4 of 5	D-01	6.03.07	137 of 393	

Note: Notwithstanding the values of the above mentioned parameters, the design wind pressure so computed at any point shall not be taken less than 1500 N/Sq. metre for all classes of structures, i.e. A, B & C as defined in IS:875(Part-3).

Note: Notwithstanding the values of the above mentioned parameters,
1. The design wind pressure "p_z" at any point (computed using Peak Wind Speed method) shall not be taken less than 1500 N/Sq. metre for all classes of structures, i.e. A, B & C as defined in IS:875(Part-3).
2. The design wind pressure "p_z" at any point (computed using Gust Factor method) multiplied by the gust factor "G" shall not be taken less than 1500 N/Sq. metre.

For Mill Bunker Building (at Tripper Floor Level)
Vertical Metal Sheeting in Cladding – Span/250
6.01.01 a) Dispersion of load in any direction through Soil.....

For Mill Bunker Building (Up to Tripper Floor Level)
Vertical Metal Sheeting in Cladding – Span/250.
However, the maximum deflection of Grating / Chequered Plate Shall be limited to 6mm.

Note: Stresses under wind load condition for all structures shall be checked for the higher of forces obtained from Gust Factor Method and Peak Wind Speed Method.
For deflection check on TP's/ Trestles Wind Load by Peak Wind Speed Method along with load due to Belt Tension and Dead Loads shall be considered.
In case this building is integrated with

