



TITLE: 1X660 MW PANKI TPS

SPECIFIC TECH. REQUIREMENT

SPECIFICATION NO. PE-TS- 426-600-C001

VOLUME - II B

SECTION - C

REV.NO. 0 DATE 09 Jan, 2018

SHEET 1 OF 1

**UTTAR PRADESH RAJYA VIDYUT UTPADAN
NIGAM LIMITED
[UPRVUNL]**

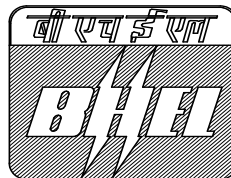


**PANKI THERMAL POWER STATION
[1 x 660 MW]**

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

SPECIFICATION NO. PE-TS-426-600-C001

**SECTION - C
SPECIFIC TECHINCAL REQUIREMENT**



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

VOLUME-VI :	CIVIL, STRUCTURAL & ARCHITECTURAL WORKS
CONTENTS	
Chapter No.	Titles
Chapter 1.	CODES AND STANDARDS
Chapter 2.	SCOPE OF CIVIL & STRUCTURAL WORKS
Chapter 3.	INSTRUCTION TO BIDDERS
Chapter 4.	SUBMISSION
Chapter 5.	GEO-TECHNICAL INVESTIGATION
Chapter 6.	GENERAL REQUIREMENT OF BUILDING / STRUCTURES
Chapter 7.	MATERIAL
Chapter 8.	LOADING
Chapter 9.	STEEL STRUCTURE
Chapter 10.	REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS
Chapter 11.	DESCRIPTION OF BUILDINGS, STRUCTURES AND OTHER FACILITIES
Chapter 12.	REINFORCED CONCRETE CHIMNEY
Chapter 13.	INDUCED DRAUGHT COOLING TOWER
Chapter 14.	COAL HANDLING SYSTEM
Chapter 15.	ASH HANDLING SYSTEM
Chapter 16.	RAW WATER PRE-TREATMENT, DM PLANT SYSTEM, EFFLUENT TREATMENT SYSTEM AND SEWAGE TREATMENT SYSTEM
Chapter 17.	ARCHITECTURE
Chapter 18.	PILING
Chapter 19.	SURVEYING WORKS
Chapter 20.	EXCAVATION AND FILLING
Chapter 21.	WATER SUPPLY, DRAINAGE AND SANITATION
Chapter 22.	SWITCHYARD CIVIL WORKS
Chapter 23.	CONCRETE ROAD AND RIGID PAVEMENT
Chapter 24.	RAISING AND STRENGTHENING OF ASH DYKE.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



1.0 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. However, all other codes (not mentioned herein) with latest editions / revision and standards along with addendums / amendments, if any, shall also be followed:

1.1 General

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.
- b) National Building Code of India.
- c) "Accepted Standards" and "good Practice" listed in the appendix to National Building Code of India.
- d) IS: 1200: Method of measurement of Building and Civil Engineering Works.
- e) IS: 1256: Code of Practice for Building Byelaws.

1.2 Earthwork

- a) IS-1498 : Classification and identification of soils for General Engineering purpose
- b) IS-3764 : Safety code for excavation work
- c) IS:7293 : Safety code for working with construction machinery

1.3 Concrete

IS-269	-	Ordinary and low heat Portland cement
IS-383	-	Coarse and fine aggregate from natural sources for concrete
IS-432	-	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS-455	-	Portland slag cement
IS-456	-	Code of practice for plain and reinforced concrete
IS-460	-	Test Sieves (all parts)
IS-516	-	Methods of test for strength of concrete
IS-1199	-	Methods of sampling and analysis of concrete

IS-1566	-	Hard drawn steel wire fabric for concrete reinforcement
IS-1786	-	High strength deformed steel bars and wires for concrete reinforcement
IS-1834	-	Hot applied sealing compounds for joints in concrete
IS-2386	-	Methods of test for aggregates for concrete (all parts)
IS:2502	-	Code of practice for bending and fixing of bars for concrete reinforcement
IS:3370	-	Code of practice for concrete structures for storage of liquids (all parts)
IS-3414	-	Code of practice for design and installation of joints in buildings
IS-4948	-	Welded steel wire fabrics for general use.
IS-6452	-	High alumina cement for structural use
IS-7320	-	Concrete slump test apparatus
IS-7861	-	Code of practice for extreme weather concreting (all parts)
IS-8041	-	Rapid hardening Portland cement
IS-8112	-	High strength ordinary Portland cement
IS:13290	-	Ductile detailing of RCC structure subjected to seismic loads
SP : 34	-	Handbook on concrete reinforcement and detailing
IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 226	-	Indian Standard Specification for Structural Steel [Standard quality]
IS : 1139	-	Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for concrete Reinforcement
IS : 1200	-	Indian Standard Specification for Method of measurement Cement Concrete Works. Part-II
IS : 1200	-	Indian Standard Specification for Method of Measurement of Part-V Formwork.
IS : 1609	-	Code of Practice for Laying Damp proof Treatment using Bitumen felts
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers

IS: 2210	-	Indian Standard Specification FOR Design of Reinforced Concrete Shell Structures and Folded Plates
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 : 2722	-	Indian Standard Specification for Portable Swing Weigh Batches for Concrete (Single and Double Bucket type)
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete.
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
IS : 3201	-	Indian Standard Specification for Design and construction of Precast Concrete Trusses
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
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 : 3590	-	Indian Standard Specification for Load Bearing Light Weight Concrete Blocks
IS : 3696	-	Safety Code for Scaffolding and Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for use as Admixture for Concrete.
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.

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
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS : 4995 (Part-I&II)	-	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolan 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 Coving 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 : 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 : 7969	-	Safety Code for Storage and Handling of Building Materials
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.

1.4 Foundations

a)	IS-1904	:	Code of practice for structural safety of building - Shallow foundations
b)	IS-2950	:	Code of practice for design and construction of raft foundations
	IS-2974	:	Code of practice for design and construction of Machine foundations (all parts)
d)	IS-2911	:	Code of practice for design and construction of pile foundation.
e)	IS-9716	:	Lateral dynamic load test on pile
	IS-6313	:	Code of Practice for anti-termite measures
f)	(Part-1 & Part-2)	:	and treatment.

1.5 Loading

a)	IS-875	:	Code of practice for design loads for buildings and structures
b)	IRS	:	Bridge Rules of Government of India, Ministry of Railways (Railway Board)

1.6 Masonry

a)	IS-712	:	Building limes
b)	IS-1077	:	Common burnt clay building bricks
c)	IS-1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
d)	IS-1528	:	Methods of sampling and physical tests for refractory materials
e)	IS-1597	:	Code of practice for construction of stone masonry (all parts)
f)	IS-2212	:	Code of practice for brickwork
g)	IS-2116	:	Sand for masonry mortars
h)	IS-2185	:	Concrete masonry units. (all parts – Hollow and Solid concrete blocks)
i)	IS-2250	:	Code of practice for preparation and use of masonry mortars
j)	IS:2572	:	Code of practice for construction of hollow concrete block masonry
k)	IS-2691	:	Burnt clay facing bricks

l)	IS-3414	:	Code of practice for design and installation of joints in buildings
m)	IS-3495	:	Methods of tests of burnt clay building bricks
n)	IS-4441	:	Code of practice for use of silicate type chemical resistant mortars
o)	IS-4860	:	Acid resistant bricks

1.7 Doors, Windows & Ventilators

a)	IS-399	:	Classification of commercial timbers and their zonal distribution
b)	IS-883	:	Code of practice for design of structural timber in buildings
c)	IS-1003	:	Timber paneled and glazed shutters (all parts)
d)	IS-1038	:	Steel doors, windows and ventilators
e)	IS-1081	:	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
f)	IS-1361	:	Steel windows for industrial buildings
g)	IS-2835	:	Transparent sheet glass for glazing and framing purposes
h)	IS-1948	:	Aluminium doors, windows and ventilators
i)	IS-1949	:	Aluminium windows for industrial building
j)	IS-2191	:	Wooden flush door shutters (cellular and hollow core type)
k)	IS-2202	:	Wooden flush door shutters (solid core type)
l)	IS-3103	:	Code of practice for industrial ventilation
m)	IS-3548	:	Code of practice for glazing in buildings
n)	IS-3614	:	Fire check doors
o)	IS-4021	:	Timber door, windows and ventilator frames
p)	IS-4351	:	Steel door frames
q)	IS-6248	:	

1.8 Roof & Flooring

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses
c)	IS-2210	:	Criteria for design of RC shell structures and folded plates
d)	IS-809	:	Rubber flooring materials for general purposes
e)	IS-1195	:	Bitumen mastic for flooring
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors
h)	IS-1237	:	Cement concrete flooring tiles
i)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles
j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish
k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring
l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping

m)	IS-5766	:	Code of practice for laying burnt clay brick flooring
n)	IS-1197	:	Code of practice for laying of rubber floors
o)	IS:2441	:	Code of practice for fixing ceiling coverings.

1.9 Waterproofing

a)	IS-1322	:	Bitumen felts for waterproofing and damp proofing
b)	IS-1346	:	Code of practice for waterproofing of roofs with bitumen felts
c)	IS-1609	:	Code of practice for laying damp proof treatment using bituminous felts.
d)	IS-3036	:	Code of practice for laying lime concrete for a water proofed roof finish
e)	IS-3037	:	Bitumen mastic for use in waterproofing of roofs.
f)	IS-3067	:	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings
g)	IS-3384	:	Bitumen primer for use in water proofing and damp proofing
h)	IS-4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.

1.10 Soil Engineering

a)	IS-1498	:	Classification and identification of soils for general engineering purposes
b)	IS-1892	:	Code of practice for sub-structure investigation for foundations
c)	IS-2131	:	Method for standard penetration test for soils
d)	IS-2720	:	Methods of test for soils (all parts)

1.11 Water Supply, Drainage & Sewerage

a)	IS-404	:	Lead pipes
b)	IS-458	:	Concrete pipes
c)	IS:651	:	Salt glazed stoneware pipes and fittings
d)	IS-771	:	Glazed fire-clay sanitary appliances (all parts)
e)	IS-774	:	Flushing cisterns for water closets and urinals other than plastic cisterns
f)	IS-783	:	Code of practice for laying of concrete pipes
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts)
i)	IS-1742	:	Code of practice for building drainage
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances
k)	IS-2065	:	Code of practice for water supply in buildings
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts)
m)	IS-3114	:	Code of practice for laying of cast iron pipes
n)	IS-4127	:	Code of practice for laying of glazed

		stoneware pipes
o)	IS-12251	: Code of practice for drainage of building basement
p)	IS-1200	: Method of measurement : Laying of water and (Part-XVI) sewer lines including appurtenant items
q)	IS-1536	: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
r)	IS-1537	: Vertically cast iron pressure pipe for water, gas and sewage
s)	IS-3486	: Cast iron spigot and socket drain pipes
t)	IS-5329	: Code of practice for sanitary pipe work above ground for buildings
u)	IS-3076	: Low density polyethylene pipes for potable water supplies
v)	IS-1538	: Cast iron fittings for pressure pipes for potable water supplies
w)	IS-1230	: Cast iron rainwater pipes and fittings
x)	IS-1729	: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
y)	IS-784	: Pre-stressed concrete pipes
z)	IS-1726	: Cast iron manhole covers and frames
aa)	IS-5961	: Cast iron grating for drainage purposes
bb)	IS-5219	: "P" and "S" traps
	[Part-I]	
cc)	IS-772	: General requirements for enameled cast iron sanitary appliances
dd)	IS-775	: Cast iron brackets and supports for wash basins and sinks
ee)	IS-777	: Glazed earthenware wall tiles
ff)	IS-2548	: Plastic water closet seats and covers (all parts)
gg)	IS-2527	: Code of practice for fixing rainwater gutters and down pipes for roof drainage.

1.12 Paving & Road Works

a)	IS-73	: Paving bitumen
b)	IS-702	: Industrial bitumen
c)	IS:1201	: Method of testing tar and bituminous materials thru' 1220
d)	IRC-15	: Standard Specification and code of practice for construction of concrete roads.
e)	IRC-58	: Guidelines for the design of plain jointed rigid pavement for highways

1.13 Earthquake Resistant Design

a)	IS-1893	: Criteria for earthquake resistant design of structures
b)	IS-4326	: Code of practice for earthquake resistant design and construction of buildings

1.14 Chimney

- a) IS-4998 : Criteria for design of R.C. Chimneys (all parts)

1.15 Induced Draft Cooling Tower

- a) CTI : Cooling Tower Institute Publication
b) BS-4485 : Specification for Water Cooling Tower

1.15 Structural Steel Work

- a) IS-800 : Code of practice for general construction in steel
b) IS-802 : Code of practice for use of structural steel in overhead transmission line
Part-I: Load and permissible stresses
Part-II: Fabrication, galvanizing, inspection and packing.
c) IS-806 : Code of practice for use of steel tubes in general building construction
d) IS-808 : Rolled steel beams, channels and angle sections
e) IS-813 : Scheme for symbols for welding
f) IS-814 : Covered electrodes for manual metal arc welding for carbon and carbon manganese steel
g) IS-816 : Code of practice for use of metal arc welding for general construction in mild steel
h) IS-817 : Code of practice for training and testing of metal arc welders
i) IS-818 : Code of practice for safety and health requirements in electric and gas welding and cutting operation
j) IS-819 : Code of practice for resistance spot welding for light assemblies in mild steel
k) IS-919 : Recommendations for limits and fits for engineering.
l) IS-1024 : Code of practice for use of welding in bridges and structures subjected to dynamic loading
m) IS-1161 : Steel tubes for structural purposes
n) IS-1182 : Recommended practice for radiographic examination of fusion welded butt joints in steel plates
o) IS-1200 : Method of measurement of steelwork and iron work
[Part-VIII]
p) IS-1239 : Mild steel tubes, tubulars and other wrought steel fittings (all parts)
q) IS-1363 : Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia. 6 to 24 mm) [all parts].
r) IS-1364 : Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm) [all parts]
s) IS-1365 : Slotted counter sunk head screws (dia range

		1.6 to 20 mm)
t)	IS-1367	: Technical supply conditions for threaded steel fasteners
u)	IS-1443	: Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	: Methods of tensile testing of steel products
w)	IS-1730	: Dimensions for steel plate, sheet and strip for structural and general engineering purpose
x)	IS-1731	: Dimensions for steel flats for structural and general engineering purposes
y)	IS-1852	: Rolling and cutting tolerances for hot rolled steel products
z)	IS-1977	: Structural steel (ordinary quality)
aa)	IS-2016	: Plain washers
bb)	IS-2062	: Steel for general structural purposes
cc)	IS-2074	: Ready mixed paint, air drying, red oxide zinc-chrome, priming
dd)	IS-2633	: Methods of testing uniformity of coating of zinc coated articles.
ee)	IS-3613	: Acceptance test for wire-flux combinations for submerged arc welding of structural steel
ff)	IS-3664	: Code of practice for ultrasonic pulse echo testing by contact and immersions methods
gg)	IS-3757	: High strength structural bolts
hh)	IS-4000	: High strength bolts in steel structures
ii)	IS-4759	: Hot dip zinc coatings on structural steel and other allied products
jj)	IS-5334	: Code of practice for magnetic particle flaw detection of welds
kk)	IS-7215	: Tolerances for fabrication of steel structures
ll)	IS-7280	: Base-wire electrodes for submerged arc welding of structural steel
mm)	IS-7318	: Approval test for welders when welding procedure approval is not required.
	[Part-I]	
nn)	IS-8500	: Structural steel – micro-alloyed (medium and high strength qualities)
oo)	IS-9595	: Recommendation for metal arc welding of carbon and carbon manganese steel
pp)	AWS D.1.1	: Structural welding code.

1.16 Painting

a)	IS-348	: Specification for French polish
b)	IS-427	: Specification for distemper, dry colour as required
c)	IS-428	: Specification for distemper, oil emulsion, colour as required
d)	IS-1477 (I & II)	: Code of practice for painting of ferrous metal in buildings
e)	IS-2338 (I & II)	: Code of practice for finishing of wood and wood based materials
f)	IS-2339	: Specification for Aluminium Paints for general purposes in dual containers
g)	IS-2395	: Code of practice for painting concrete, masonry and plaster surface
h)	IS-2932	: Specification for enamel, synthetic, exterior -

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	i)	IS-2933	:	(a) undercoating , (b) finishing Specification for enamel, exterior – (a) under- coating, (b) finishing.
	j)	IS-5410	:	Specification for cement paint.
- 1.17** a) Indian Road Congress (IRC) Bridge codes
- b) Indian Railways Standard Bridge Rules
- 1.18** **Environmental Protection**
- Charter on Corporate Responsibility for Environmental Protection (CREP)
 published in Gazette of India dated 27.08.2003.
- 1.19** CEA guide lines for Civil works for Power Plants of 500 MW and above shall
 also be followed.

2.0 SCOPE OF CIVIL & STRUCTURAL WORKS

- 2.1 This specification is to cover design, preparation of general arrangement, construction as well as fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on EPC basis.
- 2.2 The work to be performed under this specification consist of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, 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 and including revisions and amendments thereto as may be required during the execution of the work.
- 2.3 All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.
- 2.4 The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.
- 2.5 The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the Owner / Consultant. For all building and structures, foundations, etc. necessary layout and details are to be developed by the Contractor keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Also the Contractor's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Purchaser.
- 2.6 Description of various items of work under this specification and nature of work in detail are given hereinafter, but not limited to the items listed below. The complete work under this scope is referred to as CIVIL WORKS. List of various civil works covered under the scope is given below:
1. Turbine building foundation including Turbo-generator foundation and superstructure including service and maintenance bays.
 2. Switch Gear and Control Room
 3. Compressed Air Building and DG Room
 4. Steam Generator Elevator supporting structure.
 5. Foundation for steam generator / ESP / duct supporting structure.
 6. ESP control room.
 7. Mill and bunker building including bunker structures & Mill Foundations.

8. Mill reject silo and foundations.
9. Foundations for various fans and foundation for fan handling system.
10. RCC chimney of 275m height with single flue.
11. Substructure and superstructure of Natural Draft Cooling Tower.
12. Steel Trestles for supporting Ash slurry piping within plant area and dry fly ash transportation pipe pedestal up to silos near plant boundary. Modification (if required) of existing ash pipe rack is also in the scope of Bidder.
13. Fly ash silos & foundation.
14. Ash slurry pump house, Ash water pump house, transport air compressor house, combined slurry/high concentration slurry pump house, Ash water recirculation pump house and vacuum pump house, decantation well, Silo Utility Building, Ash Water Clarifier and associated civil work, HCSD Pump House. Modification (if required) of existing return channel, existing ash water recirculation pump house, existing ash slurry pump house and existing decantation well is also in the scope of Bidder.
15. Buffer hopper tower and collector tank tower structure & foundation.
16. Construction / modification of RCC pedestals for supporting Ash disposal pipes, ash water recirculation pipe and bottom ash slurry pipes upto existing ash dyke including garlanding.
17. Ash handling Electrical / Control Room
18. Switch gear/ MCC and control room for all buildings.
19. Cooling Tower Switchgear & MCC Room
20. Cooling water (CW) and Auxiliary Cooling Water (ACW) pump house, sump including forebay.
21. RCC encased Steel CW ducts from CW pump house to Turbine building, Turbine building to cooling tower including RCC thrust block. Intake RCC channel from cooling tower to CW pump house forebay.
22. A raw water pump house (intake structure) to be constructed inside plant boundary near the Lower Ganga Canal to pump the make-up water through MS pipes to Raw Water reservoir. Desilting chamber adjacent to raw water pump house to remove the silt from incoming water from Lower Ganga Canal is also in the scope of Bidder. Size of desilting chamber and raw water pump house will be as per mechanical requirement. Diversion and reconstruction to original width and alignment of existing road outside plant boundary is also included in Bidder's scope.
23. A plant water makeup pump house to be constructed near raw water reservoir to pump the make up water through MS pipes to clarifiers located in the PT plant.

24. Raw water reservoir (storage capacity shall be as described elsewhere in this specification) for running of 1x660MW unit during canal closing period is in the scope of bidder.
25. Switchgear and MCC Room near CW Pump House
26. Switchgear and MCC Room near Raw water Pump House
27. DM Plant Building, acid/alkali (chemical) storage area with RCC dyke wall, neutralization pit, acid/alkali storage tank foundation.
28. Two (2) nos. RCC type clarifiers for DM system with one (1) no. Cascade Aerator, Stilling Chamber, Flash Mixer.
29. Chemical house building.
30. DM & CPU Generation building (common).
31. Filter water sump and sludge sump.
32. Clarified Water Reservoir and Pump House
33. CW Treatment & Chlorination Plant
34. Thickener
35. Centrifuge Building
36. Hydrogen Generation Building
37. Hydrogen Generation Control Room
38. Ash Water Clarifier
39. Ash Water Clarifier Control Room
40. RCC central monitoring basin (CMB) and effluent disposal pump house.
41. RCC coal settling pond with two compartments.
42. Unloading header trench.
43. Unloading pump house, transfer pump, HFO storage tank foundation including dyke area, oil water separator pit, fencing/gate around fuel oil handling area as per statutory requirements, pressurizing pump house and all associated Civil work.
44. Fire water reservoir, fire water pump house (within clarified water reservoir and pump house) and fire station.
45. Filter water reservoir & pump house.
46. Foundation of various water pumps.
47. Foundation / superstructure for wagon tippler, crusher house, reclaim hopper, pent house etc.

48. Civil and structural work for Transfer points, conveyor tunnels, conveyor galleries and stacker/reclaimer foundation/superstructure.
49. CHP control room, wagon tippler control room, pump house and MCC room.
50. Switchyard control building and complete civil work for 400 kV switchyard, towers, equipments, cable trenches, fencing and gates around Switchyard area.
51. Switchyard structures (towers, gantries, equipment structures etc.)
52. Foundation for all power transformers in Transformer yard and other associated work including paving, fire walls, cable trenches, duct-support foundations, oil pits with connecting drains/underground pipes, chain link fencing etc. as per statutory requirements.
53. Rail track foundation for stacker/reclaimer.
54. Paving in coal stock pile area.
55. Minor site grading and leveling upto 500mm is in the scope of bidder. Finish ground level of entire plant area will be at RL m above Mean Sea Level. Finished Floor Level (FFL) of all buildings, roads and drains will be as per CEA guide lines. It is to be noted that fairly graded land (upto finished grade level of proposed Power Plant as decided by UPRVUNL) as shown in Plot plan attached with this specification shall be handed over by UPRVUNL to Contractor of this package.
56. Roads (with shoulders) network within boundary of Power Plant and connecting the same with existing road network.
57. Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement. Plant boundary wall shall be RCC framed structure consisting of columns and beams at plinth level and top of wall with Fly Ash Bricks infilled
58. Condensate Storage Tank foundation
59. Foundation of FAE Towers
60. Electrical grounding mat & earthing pits
61. Effluent Treatment Plant comprising one (1) no. sump in fuel oil area, one (1) no. API oil-water separator, FOOWS sump, one (1) no. sump for oily waste generated from Turbine Building, one (1) no. boiler area oily waste sump, one (1) no. treated water sump, one (1) no. sump for oily effluent from Switchyard area, one (1) no. common oil sump, one (1) no. boiler area sump, one (1) no. condenser waste water sump, one (1) no. TG wash water sump, one (1) no. pre-settling pit, one (1) no. ESP area wash water pit, one (1) no. ash silo wash water sump. One (1) no. high rate solid contact clarifier, one (1) no. clarified water sump, ETO RO Building, Degassed water storage tank foundation, DMF filter tank foundation, UF

filter tank foundation etc. as per system design requirement described elsewhere in this specification.

62. Civil work for Sewage Treatment Plant including equalization cum holding tank, FAB tank, tube settler, hypo contact cum filter feed tank, sludge sump and pump house, centrifuge building etc. as per system design requirement described elsewhere in this specification.

63. Auxiliary building

- Service building.
- Administrative building (Area 1500m sq. per floor, total No. of floor ground + 2 floors)
- Air washer building.
- Workshop
- Canteen building
- Training Centre
- Dozer shed and repair shed

Dozer shed shall be steel framed structure with brickwall upto window sill height and insulated double skin metal sheeting cladding above it. Roof of the building shall be insulated double skin metal sheeting on steel roof truss. The building shall provide for dozer shed space, work shop space, office rooms, stores, toilet and pantry as per functional requirements. Minimum size of dozer shed shall be 500 sqm. External finish for brick walls shall be of premium acrylic smooth paint.

- Fire station
- Ware House / Stores / Storage Yard
- Main gate, time office and security complex – 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 height and 3.0m width shall be provided at the each end. Security complex shall be RCC framed 2 storey building. Floor area of this building shall be of minimum 700m sq.

All other civil items not covered above but required for completion and proper functioning of plant shall form part of scope.

64. Paving, trenches, tunnels, channels, duct banks etc.

65. Foundation and superstructure of structural steel pipe rack and cable racks for pipes and cables for clarified water, D.M. Water, steam pipes, fuel oil pipes etc. with walkways.

66. RCC paving from power house to chimney including Boiler area.

67. RCC paving in Transformer yard

68. RCC paving in DM Plant area, around Cooling Tower (3.0 m wide), Oil storage area, Ash silo area etc.

69. RCC track (including jacking pads) connecting transformer yard to service bay in TG building including cross track in service bay.

70. Parking sheds for four wheelers and two wheelers – Size of shed shall be capable to accommodate minimum 50 No. of 4 wheelers and 2 wheelers each.
71. RCC storm water drainage system for the entire plant.
72. Dispensary and first aid centre.
73. Service water system pipelines.
74. Miscellaneous civil work and foundation like shed for outdoor pump etc.
75. Rain Water Harvesting should be implemented as per the scheme / design approved. Central ground water Authority / Board or State ground water authority or MoEF authorized agency shall be consulted for finalization of appropriate rain water harvesting technology. The necessary consultancy charges for the above agency for preparing rain water Harvesting method / scheme for the project to be borne by the Bidder.
76. Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the Client. Any infrastructure buried underground shall be demented/relocated by bidder without any additional cost.
77. The contractor has to fill or excavate the areas to the required formation levels as indicated in the plot plan.
78. Site illumination work including lighting towers shall be provided in Coal yard area, Switchyard area including all other plant areas.
79. Road Weigh Bridge and Control Room

These shall be RCC framed structure with RCC roof and brick cladding. Adequate windows shall be provided for ventilation & lighting. Roof shall be given liquid membrane water proofing treatment. Flush welded steel doors shall be provided for personnel movement. Toilet facilities shall be provided.
80. All underground structures such as basement, sump and water retaining structures etc.
81. Architectural finishing including flooring, paving, side cladding with sheeting of brick masonry, walls, plastering, painting, false ceiling, doors & windows, roof treatment etc. for all buildings covered under this package.
82. The work also includes :
 - (i.) Site surveying.
 - (ii.) Soil investigation and preparation of soil investigation report and suggestion of type of foundations including design of piles.
 - (iii.) Implementation of ground improvement and post improvement evaluation of sub surface properties if required.

- (iv.) Preparation of Architectural drawings.
- (v.) Design, preparation of drawings and construction of all structures.
- (vi.) Preparation of as built drawings of all structures and facilities to reflect as built status of construction.
- (vii.) Submission of as built drawings in Autocad in CDs.
- (viii.) Plumbing & sanitary works.
- (ix.) Painting.
- (x.) Anti-termite and anti-weed treatment in all areas / buildings as per IS: 6313.
- (xi.) All temporary roads and approach roads necessary for construction purpose shall be of WBM for a minimum width of 4m.
- (xii.) All permanent roads as stipulated in this specification.
- (xiii.) Green belt development
- (xiv.) Internal/External compound wall is in the scope of bidder.
- (xv.) Site clearance.
- (xvi.) Demolition of existing structures / facilities, if any, as identified by Owner.
- (xvii.) Supply, fabrication & erection of miscellaneous fixtures, stairs, ladders, railings, inserts, embedments etc.
- (xviii.) Foundations/platforms/staging required for erection of equipments.
- (xix.) Supply of cement, reinforcement steel and structural steel.
- (xx.) Obtaining all necessary statutory clearances prior to execution work from concerned Competent Authorities.
- (xxi.) Making all necessary arrangements for access to the storage yard from the nearest approach road and further to the actual site of work and maintenance of same in order to facilitate transportation of machinery and equipment such as cranes etc. assessing the suitability of existing roads.

It is not the intent to specify herein all the works in the scope of this contract. All other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant are deemed to be included in the scope of the Contractor.

In the event of conflict between requirement of any two clauses of this specification, or different codes / standards, the more stringent requirement as per the interpretation of Owner is to be followed by EPC contractor.

All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.

2.7

Protection of existing utilities and services

During construction, the contractor shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other sections or as instructed by the Owner.

In addition to the requirements as specified, herein the contractor shall comply with the following requirements:-

- a) Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the contractor shall take adequate measures to prevent undermining of utilities and services presently in services.
- b) Protect existing or new utilities and services where required by the contractor's operations and/or as directed by the Owner. The contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.

3.0 INSTRUCTION TO BIDDERS

3.1 Data to be furnished by Bidder at the time of Bid

- 3.1.1 A write-up on survey to be undertaken indicating grid, intervals for taking spot levels, contour intervals, precision of surveying instruments proposed to be used, drawings that will be prepared, details to be covered by survey etc.
- 3.1.2 Detail general arrangements / architectural drawings of all buildings and structures showing dimensions, levels, plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc. This can be provided at the time of detailed engineering.
- 3.1.3 Detail design criteria proposed to be adopted for each building, structures, foundations, facilities etc.
- 3.1.4 A write-up with drawings on layout of cooling water (CW) system indicating sizes and design loads for CW conduits, seal pit, channels and proposed method of construction etc.
- 3.1.5 Size, concrete grade and other design parameters and construction details etc. for 275m high RCC chimney with steel single flue. The top most flue can shall be of stainless steel.
- 3.1.6 Details of thermal insulation for ceiling and detail of false ceiling assumed with manufactures catalogue and areas where they propose.
- 3.1.7 All deviations from bid document shall be furnished by the Bidder.
- 3.1.8 List of equipment to be deployed and rates of labour assumed by the bidder and by other sub-contractors to be associated with him is to be furnished.
- 3.1.9 List of softwares proposed to be used against various areas, for analysis, design, construction etc. their source & along with validation report for the softwares.
- 3.1.10 The list of documents indicated elsewhere of this section to be submitted by the contractor to the Owner for his approval and manner in which the same need to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore, it is necessary that bar charts for buildings / structures / area wise shall be submitted for design / drawing activity indicating.
- a) A Level-1 pert chart showing the starting and completion date of all civil construction activities.
 - b) A Level-2 pert chart showing the time required for preparation of design criteria, for approval of design criteria by Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner. This part shall be taken into account the construction schedule (Level – 1 part).
 - c) A Level-3 network for all civil works shall be submitted to Owner for monitoring of progress of works at site.

- 3.1.11 List of all sub-contractors that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the contractor etc. shall be submitted to Owner. Only the sub-contractor approved by Owner shall be engaged by the contractor on the job.
- 3.1.12 Contractor has to set-up a testing laboratory equipped with the following minimum apparatus, materials and competent trained staff required for carrying out field tests:
- Slump cone apparatus to measure slump.
 - Concrete cube testing machine with adequate number of moulds of (15cmx15cmx15cm) to measure compressive strength of concrete.
 - Vicat apparatus to find initial and final setting time of cement.
 - IS sieves with vibrating machine to determine fineness modulus of coarse and fine aggregate.
 - Abrasion & impact testing equipment for testing coarse aggregate and apparatus to determine flakiness index of aggregates.
 - Complete apparatus for the test of air content of concrete by pressure method as per IS:1199.
 - Density bottle to determine sand bulkage.
 - Hydrometer for testing pH value of water
 - Thermometer for checking temperature
 - Apparatus for measuring proctor density, water content of compacted soil determining CBR values.
 - All apparatus for determining dry density and water content of sand/soil and aggregates. Any other equipment felt appropriate by the Owner for measurement of paint thickness, testing of structural members, welding etc. The testing machines shall be recalibrated periodically and as directed by Owner/manufacturer / consultant to detect errors. The moulds for cubes shall be checked frequently and made to conform to specifications contained in IS-516.
 - The water to the main plant will be made available from Lower Ganga Canal situated just on the North side of the Power Station as shown in the layout plan.

3.2 Inspection of Site by Bidder

- 3.2.1 Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, sub-soil conditions, natural

drainage etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.

Map indicating all crossings like high ways / railways / nala / river and bridges etc. may be collected from owner's office.

- 3.2.2 The submission of a bid by the Bidder will be considered as an evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.

The contractor shall organize his own arrangement to transport his equipment, men and materials so as to match the construction schedule.

- 3.2.3 Proof checking of structural design of following structures shall be got from SERC Chennai or IIT Roorkee by the Contractor at his own cost.

- (a) Design of TG Foundation including Non Destructive Testing of TG column and Deck slab after construction.
- (b) Design and connection for Power House building main structure frame work.
- (c) Design and connection of Mill Bunker building main structural frame work including design of Bunkers.
- (d) Design of 275m high RCC Chimney
- (e) NDCT
- (f) Wind Tunnel test for RCC Chimney. This shall be conducted by an independent agency which be subjected to approval of UPRVUNL.
- (g) Chimney profile laser testing and Non Destructive testing of Concrete Wind Shell.

- 3.2.4 This power station is to be built over the site cleared of old power station and old colony. The obstruction on account of availability of any under ground structure, remnants may be there, for which the firm shall not be paid extra. Therefore it is advised that firm should have a detail view of the site before coating the prices.

3.3 Construction Tools & Materials Supplied by Contractor

- 3.3.1 Contractor shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the various works cover under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expenses. No claim shall be entertained for mobilizing additional equipment and/or personnel to complete the work within the stipulated time.

- 3.3.2 Contractor shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.

- 3.3.3 The contractor shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the contractor at his own cost as an alternative arrangement, in case electrically operated equipment are proposed to be brought to site.

- 3.3.4 The contractor shall ensure continuous supply of coarse and fine aggregate conforming to the specification for the duration of the contract period and extended period, if any. Adequate stocks are to be ensured before the onset of monsoon, because the approaches to the queries becomes difficult during monsoon.
- 3.3.5 All materials supplied by the contractor shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings/specification.
- 3.3.6 Contractor shall furnish manufacturer's test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Contractor's cost in case Owner so desire.
- 3.3.7 The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor's cost.

The Owner reserves the right to instruct the Contractor to remove all materials, which do not meet the specification requirements.

3.4 Work Execution and Supervision

- 3.4.1 Contractor shall have at the site accredited and qualified engineers and foremen / supervisors with adequate number of years of experience in execution of similar works and also operators of machinery and equipment, for satisfactory progress and timely completion of the work.
- 3.4.2 Contractor's Engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.
- 3.4.3 Contractor shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.
- 3.4.4 In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accidents. He shall also report such accidents to all the competent authorities wherever such reports are required by them.
- 3.4.5 All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Contractor.
- 3.4.6 Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.
- 3.4.7 During inclement weather, rains etc. contractor shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective

measures shall be at contractor's cost and any damage to works shall be made good by the contractor at his own expense.

- 3.4.8 Should the work be suspended by reasons of strikes / riots by Contractor's own employees or any other causes whatsoever save and except the force majeure condition, Contractor shall take all precautions necessary for the protection of works and make good, at his own expenses, any damage arising from any of these causes.
- 3.4.9 During the course of contractor's works, other works either by the Owner or by the Contractors or by both simultaneously will be in progress within the project area. Contractor shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.
- 3.4.10 The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth, which is hazardous & detrimental to health, and affect safety of the work place.
- 3.4.11 All material supplied shall conform to the specification. Entry of unwanted materials shall be prohibited.

4.0 SUBMISSION

The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (metric system) and shall be made on AUTOCAD. Software used for design shall be validated and established ones like STAAD Pro, NISA, and ANSYS. Hard and soft copies of the drawings / document to be furnished to the OWNER. The list is not exhaustive but indicative only.

- 1) The analysis of TG building, Mill building, ESP control room, Chlorination building, Switchyard control building, CW pump house, Raw water pump house, Ash water pump houses, Service building and all other buildings/structures are to be done by developing 3D mathematical model adopting response spectra method of analysis as per IS: 1893-2002 & 2005, in addition to wind load analysis as per IS: 875 Part-3.
- 2) Preparation of design drawings with maximum detailing possible and developing all possible connection / joint details for all the buildings within the scope of civil / structural works.
- 3) General plant layout drawing with coordinates of roads, boundary wall, and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.
- 4) Drawing showing underground facilities with coordinates like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.
- 5) Soil investigation report based on additional geo-technical investigation carried out by CONTRACTOR along with foundation recommendation for various buildings / structures / facilities.
- 6) Storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc for storm water drainage system.
- 7) Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement.
- 8) Design basis memorandum for all buildings, facilities, services and structures.
- 9) Drawing showing loading data at various levels for all buildings and structures.
- 10) Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings. For main plant building CONTRACTOR shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts.
- 11) Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.

- 12) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc.
- 13) Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road / rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc.
- 14) Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling, etc.
- 15) Design calculations and drawings for plumbing and building drainage.
- 16) Design calculations and drawings for switchyard structures, transformer yard, etc.
- 17) Design calculations and drawings for structures pertaining to condenser Cooling water system.
- 18) Design calculations and drawings for civil structures / works associated with fuel oil handling system, ash handling system, coal handling system, Ash disposal system, etc.
- 19) All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Owner.
- 20) Details of corrosion protection measures for all structures.
- 21) Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings.
- 22) All design and drawings for the Cooling towers.
- 23) All design and drawings for RCC single flue chimney.
- 24) All design calculations and drawings for foundation of Boiler and ESP area structures.
- 25) Shop fabrication drawings of all structural steel work along with design calculations
- 26) Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, transfer towers, conveyor galleries, TG foundation and other machine foundations.
- 27) Write up on various statutory requirements and their compliance for various buildings and facilities.
- 28) Quality assurance and Quality Control procedures as per attached guide lines. (refer Vol-II of specification)

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- 29) Copies of all reports on investigation and studies carried out by the CONTRACTOR as per the scope.
- 30) Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.

5.0 GEO-TECHNICAL INVESTIGATION

- 5.1 Report of Preliminary soil investigation work available with UPRVUNL within proposed Power Plant area covering major structures/facilities tentatively located shall be provided to the bidders.
- 5.2 The information furnished in geotechnical report is only for the guidance of the bidders. Owner does not take any responsibility for the correctness and interpretation of the result. Any variation of the said information shall not constitute a valid reason in affecting the terms and condition of the bid. The bidder shall fully satisfy himself about the nature of soil expected to be encountered, including the type of foundation, bearing capacity, sub-soil water etc. prior to the submission of his bid.
- 5.3 Detailed geotechnical investigation shall be carried out by the Contractor on award of work. Based on the plot plan developed, the contractor shall identify proposed locations of boreholes and other tests and obtain the approval of Owner prior to commencing the investigation. In the power block bore holes shall be provided and spread judiciously to cover all major buildings as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of Switchyard. In the offsite areas also it shall be ensured that the bore holes are provided near all major structures. If the final geotechnical investigation report is found to be in variance with the assumptions / preliminary investigations made during bid stage, the contractor is not eligible for any extra claim or time extension. Bidder should note that stringent soil parameters (including pile capacities/bearing capacities) between soil data annexed in this specification and data obtained as per soil report based on geotechnical investigation carried out by Contractor shall be considered in final design.
- 5.4 Following field tests shall be conducted:
- Bore holes and standard penetration tests
 - Static plate load tests
 - Cyclic plate load test
 - Cross hole shear velocity test
 - Field permeability tests
 - Field density tests
 - Vane shear tests
 - Static cone and dynamic cone penetration tests
 - Electric resistivity tests
 - Pressure meter tests
 - Percolation test
 - California bearing ratio tests
 - Seismic Refraction Tests
 - Block Vibration Test
- 5.5 Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 30.0 m (approximate) OR upto 5.0 m in rock having RQD of 50% or more OR depth of refusal whichever is critical.
- 5.6 Standard penetration test (SPT) and collection of undisturbed soil samples (UDS) shall be carried out alternatively at 1.0m intervals and at significant

change of strata. The interval shall be increased to 1.5m below 5m depth of boring. UDS shall be replaced by SPT in cohesion less strata. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth. In case, rock is met at the proposed founding level, bore hole shall be extended up to 10m depth in the rock.

5.7 Dynamic Cone Penetration Test (DCPT)

The test equipment and procedure shall meet the requirement of IS:4968 (Part II). The driving shall not be done for more than 30 cm at a time after which it shall be stopped for a minute or two. The tests shall be terminated when the blow counts exceed 35 for 100 mm. penetration when the cone is dry and 20 for 100 mm. penetration when the cone is penetrated by circulating slurry.

The results shall be reported in a suitable tabular form giving below counts for every 30 cm. penetration supplemented by a graphical plot of blow count versus depth.

5.8 In rock strata, core recovery, Rock Quality Designation (RQD) and Room Mass Rating (RMR) shall be noted carefully for each run, immediately after cores are taken out of barrel.

5.9 During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table.

5.10 Following laboratory tests shall be conducted: (preferably on Undisturbed soil samples and if UDS is not possible, on remoulded soil samples)

- i) Grain size analysis
 - a) Hydrometer analysis
 - b) Sieve analysis
- ii) Field density and moisture content.
- iii) Specific gravity.
- iv) Chemical analysis of soil and ground water including sulphates, chlorides, pH value etc.
- v) Chemical analysis of 2:1, water:soil extract of the samples giving SO_3 content.
- vi) Consistency Index: Liquid limit, plastic limit, plasticity index, shrinkage ratio.
- vii) Consolidation test giving all relevant information.
- viii) Swelling pressure and free swell index for expansive soils.

- ix) Unconfined compressive strength on undisturbed soil samples
- x) Direct shear test.
- xi) Triaxial compressive strength tests:
 - a) Unconsolidated undrained test
 - b) Consolidated undrained test
 - c) Consolidated drained test
- xii) Moisture density relations for Standard Proctor and Modified Proctor tests.
- xiii) Crushing strength, specific gravity, unit weight, water absorption test of rock specimens of NX size.
- xiv) Permeability test.

5.11 The Geotechnical investigation report shall necessarily include but not be limited to the following information:

- a) Recommended types of foundation.
- b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
- c) Type of piles recommended with reasons for the same, length, diameter, allowable capacity (lateral pullout and vertical) of individual and groups of piles, negative skin friction, if any, and magnitude of estimated negative skin friction.
- d) Recommendations for values for modulus of sub grade reaction for foundation design by elastic method.
- e) Type of cement to be used for concrete substructures and in stone/brick masonry foundations with reference to the chemical nature of subsoil and ground water.
- f) Recommendations regarding excavations (shallow & deep), embankment, safe sides slopes for excavation and embankment, dewatering, site drainage etc.
- g) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.

5.12 The Bidder shall carry out the topographical survey of the area within leveling boundary to establish existing ground levels before commencing the detailed design and site leveling activities. All levels shall be established with reference to the permanent bench mark existing near the plant site. Base on field observations the bidder shall prepare detailed survey maps showing topographical details and contour levels and submit the same to Purchaser / consultant for approval. If any deviation in the soil parameters is found in

Geotechnical investigation done by the Bidder, it will not form any basis of extra claim.

6.0 GENERAL REQUIREMENT OF BUILDING / STRUCTURES

The CONTRACTOR shall obtain and be conversant with all laws, by-laws and regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The CONTRACTOR shall provide the drawings and documents for such statutory approvals.

6.1 Roof Access

All roofs shall be provided with access thorough a staircase / cage ladder. Minimum 1000 mm wide access path shall be provided with tiles to approach equipment on roof.

6.2 Platform and Walkways

Platforms shall be provided to all major equipment, not directly accessible from - the floors, for maintenance. Platforms and connecting walkway shall have a minimum width of 750 mm. However, in case of space restriction, the minimum allowable clear width shall be 600 mm. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways. However, actual width of platforms and walkways shall be as per approved mechanical GA drawings.

All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consists of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

Continuous walkway at least 750 mm (Wherever occurs) wide shall be provided along the crane girder level with handrails, on both side of the building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

Finished floor level boiler area / transformer yard area shall be kept 200mm lower than the finished floor level of power house building.

6.3 Edge Protection

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corners expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. around the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of. RCC cable / pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

6.4 Anchor Bolts and Inserts Plates

Anchor bolts shall be designed for working stress, in tension only, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked.

Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall also be

checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

Insert plates required for the equipment supplied by BTG vendor will be supplied by BTG supplier and same shall be fixed in position under this contract and supply and fixing of all the balance inserts shall be under the scope of this contract.

6.5 Vertical Headroom

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.

Finished floors to ceiling (buildings)	3000 mm
Doors, Walkways, Platforms, Stairs etc.	2100 mm
False ceiling of office areas	2400 mm
Above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
Main roads / Railway crossings & crane access	7000 mm
Other plant roads and truck access	5000 mm
Cable & Pipe rack (except at road and rail crossings)	3000 mm

6.6 Anti Termite Treatment

Pre-constructional anti termite treatment shall be given to substructure of all buildings/structures/systems and shall include but not limited to column pits, wall trenches, foundations filling below the floors etc., as per relevant codes and standards.

6.7 STAIRS AND LADDERS

6.7.1 Steel Stairs

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000mm and maximum inclination with horizontal of 35.75°. However, in case of space restriction, minimum clear width upto 750mm and slope upto 45° may be provided. The vertical height between successive landings shall not exceed 5m. Channels (minimum MC200) shall be provided as stair stringers. Treads shall be minimum 250mm wide of chequered plate / grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180mm.

6.7.2 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be

vertical and its angle with vertical shall not exceed 5° . Ladders shall be of minimum 450mm clear width with 20mm diameter MS rungs spaced at 300mm (maximum). Ladders shall be provided with a safety cage of minimum 750mm diameter clear when the top of ladder is more than 4.5m above the landing level. However safety cages shall start at 2.5m above the lower landing level.

6.7.3 RCC Stairs

All stairs shall have maximum riser of 180mm and a minimum tread of 250mm. However, for Administration & Control room building riser shall be limited to 150mm and tread width of 300mm. Minimum width of stairs shall be 1200mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50x25x3 angle or PVC nosing shall be provided for edge protection of RCC stairs.

6.8 Handrails

Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections / balconies, walkways, platforms, steel stairs etc.

All handrails shall be of 32mm nominal bore MS pipes (medium class) as per relevant codes, galvanised using 750 gm/sq. m of zinc. Handrails for platforms, walkways and projections shall be a two-rail 450mm below the top rails. Handrail post spacing shall be limited to 1500mm as far as possible but can be proportioned to the length of the protected horizontal opening. In such a case spacing shall not exceed 1850mm center to center of posts. Handrails shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. For platforms at elevation more than 30m, three rail system with top rail at 1500mm shall be adopted.

For RCC stairs, handrails with 20mm square MS bar balustrade with suitable MS flat & aluminium / Teakwood handrail shall be provided, unless specifically mentioned otherwise.

6.9 Expansion/Construction Joints

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made watertight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6mm and minimum width 225mm. At other joints these shall be 150mm wide.

Two part polysulphide sealant conforming to relevant codes shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to relevant codes shall be used. Preformed bitumen impregnated fibre board conforming relevant codes shall be used as joint filler. For joint treatment of coal handling system structure, refer clause No. 14.1 of chapter 14.

6.10 Brick / Stone Masonry And Parapet Wall

All masonry works shall be designed in accordance with relevant codes as applicable. Structural design of load bearing and non load bearing walls constructed with fly ash bricks shall be in accordance with criteria specified by section-4 of National Building Code of India, Part-VI and codal provisions. For thickness and details of brickwall refer Chapter-17 of this Volume.

All walls shall be non-load bearing in filled panel walls. External walls of all buildings shall be atleast one brick thick. All internal walls shall be atleast one brick thick except for internal partition walls for office area, canteen, change room, first aid rooms and toilets, which may be half brick thick. RCC bands (transoms and mullions) shall be provided wherever necessary to curtail the unsupported length / width of the wall.

50mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry works. Water proofing compound shall be Zydex, Sikka or similar make.

Fly Ash Bricks having minimum 75 kg/sq.cm compressive strength shall be used for non-load bearing superstructure brick work. Cement and sand mortar 1:5 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided. Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 2000 mm centre to centre. The size of transoms / mullions shall be minimum 115mm square with four numbers, 8 mm dia bars and 6mm stirrups 150 mm centers.

Almost all the brickwork shall be plastered with cement mortar. Brickwork in superstructures uncovered by plaster shall be executed by 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 should check workmanship frequently with plumb, spirit level, rule and string. All brick work shall be cleaned at the end of day's work. In case of face bricks involvement the brickwork shall be in composite shape with face bricks on the exposed face and balance in routine bricks, maintaining the bond fully; using carborandum stone for rubbing down. Where face bricks are not needed, 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.

For partition walls two reinforcement bars shall be placed at every fourth layer. Chicken wire mesh shall be provided at the junction of RCC & brick work.

The masonry works shall be cured for a period of 14 days after laying and plaster shall be cured for a period of 7 days.

Type, thickness and height of external wall, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee.

All upstands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 750mm and thickness 125 mm.

6.11 Waterproofing Of Underground Structures

Water proofing / Damp proofing of all underground structures like water retaining structures, track hoppers, transfer house, conveyor tunnel & other deep underground structures shall be done by providing following treatments.

Chemical injection grouting for inner faces (details as specified below)

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 as per manufacturer's specifications shall be provided directly on the concrete surface.
2. 50 mm thick P.C.C (M15 grade) with 10 mm nominal size coarse 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. 50mm thick P.C.C (M15 grade) with 10 mm nominal size coarse aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

6.11.1 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.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably using percussive 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.

All liquid retaining / conveying structures including sumps of pump house shall be tested for water tightness for as per IS-3370 and 6494 and in case of

leakage, seepage, the same shall be rectified by chemical injection grouting as specified above.

6.11.2 POLYMER MODIFIED CEMENTITIOUS COATING

6.11.2.1 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.

6.11.2.2 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.

6.11.2.3 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.

6.11.2.4 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 push 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.

6.12 Paving

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 250mm compacted thickness for normal duty paving and 400mm compacted thickness for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum and sand followed by 75 mm thick PCC of M7.5 grade with 40 mm nominal size aggregate. Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification. The reinforcement shall consist of minimum 8mm diameter bars at 200 mm c/c of grade Fe 500 at top and bottom in both directions. Actual reinforcement in paved slab shall be designed depending upon the duty and loading on the pavement.

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 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 PCC concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 200mm thick with 63 mm and down aggregate with interstices filled with selected moorum and sand.

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 hardener shall be provided.

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 shall be drained to the nearest storm water drain.

Sewer lines 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, Main Plant Building, Control Room & transformer yard area to sewage treatment plant.

Entire switch yard shall be provided with 75mm paving of 20 to 40mm size stone aggregate on top and 75mm paving of 20 mm stone aggregate below. Before laying the paving, the ground surface shall be treated with antiweed chemicals as per manufacturer recommendations.

6.13 Security Gate

Emergency Gate shall be provided in addition to the main gate. Main Gate shall have two separate entry one for project site and other for fly ash silo trucks movement. Gate latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Padlocks shall be provided and the key shall be in accordance with the Purchaser's requirements.

Cantilever type motorized sliding gate shall be furnished at the main plant entrance. The gate shall be operable by push button at both the guard house and the security office in the Administration / Plant Service area, and by card reader or key switches.

The road near the main entrance to be widened additionally by 7.5 m on either sides of the road for parking of vehicles for security check.

Suitable median arrangements to be made.

Security cabin to be provided on either sides of the road near the main gate.

Elevated platform either in steel structure / Brick work or RCC to carry out checking on Lorries/Tippers by security personnel while the vehicles getting in or going out from the premises.

6.14 Fencing

Fencing with toe wall and steel gates shall be provided around the transformers & Switchyard. Fencing shall comprise of P.V.C coated GI chainlink fencing of minimum 8G (including PVC coating) of mess size 75mm and of height 2.4 m above the toe wall. The diameter of steel wire for chain link fence (excluding P.V.C. coating) shall not be less than 12G. Fence post shall be of precast R.C.C. of minimum M20 grade. All corner posts will have two stay posts and every 10th post will have tranverse stay post. Suitable R.C.C foundation for the post and stays shall be provided based on prevailing soil condition. Gates shall be with locking provisions. The toe walls of fly ash bricks shall be provided between fence post all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick with PCC coping (1:1.5:3) and shall extend minimum 300mm below the formation level. The toe wall shall be plastered on both sides and painted with two coats of cement paint of approved colour and shade. Toe walls shall be provided with weep holes at suitable spacing.

Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

6.15 Watch Tower

Watch Tower shall be constructed with RCC frame work. Floor of tower shall be at least 6m above graded level.

Covered area for each tower shall be approx. 25 sqm. Number of towers shall be such that the complete periphery of the plant can be watched from the towers but in no case the number of towers shall be less than twelve.

6.16 Plinth Protection

All buildings shall be provided with 750 mm wide plinth protection all round. It consist of 50mm thick PCC M20 grade with 12mm maximum size aggregate over 200mm thick stone soling using 40mm nominal size ramped, consolidated and grouted with fine sand.

6.17 Miscellaneous Requirements

Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection on sunshade from the wall shall be minimum 450 nm over window openings and 750 mm over door openings.

Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.

No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.

All cables & pipes in outlying area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in transformer yard area and some other localized area where the same can run in RCC trenches. However, for facilities for which buried pipe & cables are permitted by Purchaser, the same can be provided. In case of trestles, minimum 7.0 m head clearance shall be provided for road crossings. In other areas, the clear height shall be 3.0m minimum.

All cable and pipe trenches shall be of RCC of minimum M25 grade. Trenches located outside buildings shall project at least 200mm above the finished formation level so that no storm water shall enter into trench. The bottom of the trench shall be sloped suitably for draining out the collected water into sump pit. The pre-cast covers shall be of minimum M30 grade and shall not weigh more than 65kg. Lifting hooks shall be provided in the pre-cast covers. Pre-cast covers shall have edge protection angles at top and bottom on all the four sides along with lugs.

Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.

All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.

Mild steel bars required for earthing / grounding mat shall also be supplied and installed.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings.

Connection work at terminal points is included in the scope of the Bidder.

Ground floor slab of all the buildings excluding building mentioned in Chapter 14 (Coal Handling Plant) shall be of minimum 150mm thick of M-25 grade laid over minimum 75mm thick PCC and 230mm soling of 63mm down graded aggregates (minimum) course unless specifically mentioned otherwise. The reinforcement shall consist of minimum 8mm diameter bars at 200 mm c/c of grade Fe 500 at top and bottom in both directions.

All openings in external walls provided for pipes, cables, duct etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.

Natural lighting & Ventilation

The area of windows shall be a minimum 10 % of the floor area to ensure adequate natural lighting. Fans shall be provided in general office areas as per standard norms. Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

6.18

Statutory Requirements

All the applicable statutory rules pertaining to Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act etc., and stipulations of other relevant

statutory authorities shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 600 mm wide or as per approved mechanical GA drainings) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.

Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC.

For fire safety requirements of buildings, National Building Code of India shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.

7.0 MATERIAL**7.1 Structural Steel**

Steel will conform to Grade-A of IS:2062 (latest) for rolled steel members or plates upto 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to Grade-B (killed and normalized) of IS: 2062(latest) shall be used except for crane girders where Grade-C (IS: 2062) steel shall be used. Steel shall be procured from SAIL or any other approved main producers.

Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 8 mm O/P.

Complete hopper including vertical and conical portion of bunker in mill building shall be provided with lining of atleast 6mm thick SS plate grade SS 316L .

The electrodes classification as per AWS shall be as follows:-

- a) For welding of stainless steel to stainless steel : E308L
- b) For welding of stainless steel to mild steel : E309

7.2 Cement

Ordinary Portland Cement (OPC) Grade 43 shall be used for all structures.

7.3 Reinforcement

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 500 conforming to IS:1786 – latest. Reinforcement steel shall be of either of SAIL, RINL make or equivalent as approved by UPRVUNL.

Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.

Welding of reinforcement shall not be carried out without the permission of the Owner.

Projecting reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time.

8.0 LOADING**8.1 Dead Loads**

Dead loads shall include the weight of structure complete with finishes, fixtures & partitions and shall be taken as per IS: 875 (Part-I)

8.2 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 & structure" 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)	3.00
	ii) Ground floor (Heavy equipment storage area)	5.00
	iii) Mezzanine Floor	1.50
	iv) Operating Floor	
	a) Rotor Removal area Rotor removal area beams shall also be checked for $\frac{1}{2}$ the rotor load at the center of beam	5.00
	b) Equipment Laydown area	3.00
	v) Gratings, chequered floors, walkways, platforms, stairs etc.	0.50
	vi) Roof (Where no equipment are located and non-accessible)	0.15
	Roof (where equipment are located and accessible)	0.50
B)	Deaerator and Heater Bay	
	i) HP / LP heater floor	2.0
	ii) Deaerator floor	1.5
	iii) Cable gallery	0.50 (In addition)

Sl.No.	Location	Imposed Loads (T/Sq.m) to this actual cable load shall be considered)
	iv) MCC & Control Building floors	1.00
	v) AHU room battery room, air washer room	1.5
C)	Mill & Bunker Bay	
	i) Ground Floor	2.5
	ii) Feeder Floor	2.00
	iii) Tripper Floor	2.00 Beams however shall be checked for feeder/tripper concentrated load
	iv) Roof	0.15 (where no equipment are located) 0.50 (where equipment are located)
	v) Dust Load for flat roof For inclined roof	0.1 0.05
D)	Pump Houses operating floor	1.50
	Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, Cooling Water Ducts etc.	
E)	In addition to earth pressure and ground water pressure, the surcharge load of 2T/sqm. shall also be considered for design of all underground structures.	
	Road Culverts / Bridges and its allied structures including RCC Pipe Crossings & Road Crossing of Trenches.	
F)	Design for class 'AA' loading (wheeled & tracked both) and checked for class 'A' loading as per IRC Standard.	
G)	Covers for Channels / trenches	Trench cover at entry to building and road crossings shall be designed for live load of 100 kN at centre. Trench cover at other location shall

Sl.No.	Location	Imposed Loads (T/Sq.m)
		be designed with a surcharge of 100 kN/m ² or a concentrated load of 100 kN at center which is worst.
H)	Railway Supporting Structures, Rail Culverts	As per railway 'Bridge Rules'
I)	Boiler / ESP Support Structures	0.50
J)	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
vi)	Inclined Roofs	As per IS:875 (Part-II) 0.50 T/sq.m or a concentrated load of 0.3 T/m which ever is greater
vii)	Walkways (General).	0.50
viii)	Walkways of conveyor galleries.	0.50
ix)	Floor of control room of switchyard control building	1.00
x)	Cable and pipe trestles	0.20 for walkway and in addition, friction loads as applicable.

Note:

- Additional load for cable, piping / ducting, shall be considered as applicable.
- Hung load shall be based on minimum loading equivalents of 1 kN/ m² for piping and 0.5 kN/m² for electrical ventilation and air conditioning.
- Loading resulting from concentrations of facilities in specific areas shall be substituted where listed base loadings are excluded
- Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.
- Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.

8.3 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.

8.4 Crane Loads

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.

8.5 Seismic Load

- Seismic analysis shall be carried out as per the latest edition of IS:1893 (Part 1 & 4). Zone-IV shall be considered for design.
- The structures shall be classified into four categories as per table 5 of IS:1893 (Part4).
- Importance factor for each structure shall be as per Table 2 of IS:1893 (Part4).
- Method of analysis for each structure shall be decided as per clause 10.3 IS:1893 (Part4), which depends on the seismic zone & category of the structure.
- Response Reduction factor shall be as per Table 3 of IS:1893 (Part4).

8.6 Wind Load

Basic wind speed at project site is 39 m/sec. as per IS:875 -1987 Part-3

Probability factor, (k1 risk coefficient), terrain, height and structure size factor, k2 and topography factor, k3 shall be as per IS:875.

8.7 Damping in Structures

The damping factor to be adopted shall not be more than as indicated below:

Type of Structure	Wind Load	Seismic Load
a) Welded steel structure	1%	2%
b) Bolted steel structure	2%	2%
c) RCC structure	1.6%	5%

8.8 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.

Following temperatures shall be considered for design of all buildings and structures under this package :

- Mean Daily minimum ambient temperature during coldest month of the year = 4° C
- Mean Daily maximum ambient temperature during hottest month of the year = 50° C

8.9

The following densities shall be considered for design of coal bunkers:

(a)	For volume calculations	:	800 kg/cum
(b)	For structural design	:	1200 kg/cum

The coal bunker will be designed as per criteria outlined in IS:9178 (Part I&II)

The following densities shall be considered for design of ash silos:

(a)	For volume calculations	:	750 kg/cum
(b)	For structural design	:	1600 kg/cum

The coal bunker will be designed as per criteria outlined in IS:4995.

9.0 STEEL STRUCTURE**9.1 Framing**

All steel framed structures shall be either “rigid frame” or “simple space frame” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

The power house building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

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.

Minimum size and maximum spacing of shear connectors shall be ISA 75x75x6 and 500 mm respectively. A minimum height of 75 mm shall be provided for the shear connectors.

Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level.

9.2 Design Concepts

Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc. Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loadings.

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. In the analysis of main plant building & bunker building, the stresses arising due to temperature must be considered.
- d. 'Lifted load' of crane shall not be considered during seismic condition.

- e. 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.
- f. 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 standing 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.
- g. Permissible stresses for different load combinations shall be taken as per relevant IS codes.
- h. Frictional force between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800 (latest) and other relevant IS standards. For design of coal bins and hopper IS:9178 (Part I to III) shall be followed.

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.

Permissible stresses for different members shall be allowed to exceed upto 33.33% only under normal loads along with wind and seismic conditions. The members which are designed primarily to resist wind load such as bracing members, no increase in permissible stress will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) The following criteria shall be used in determining minimum load: Use 90% of the column dead load, No live load is used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.

Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself. No anchor pockets in foundation shall be allowed. Design of base plates shall be based on design pressure on foundation which shall not exceed the following:

Pedestal in concrete grade M20	5.0 N / sq.mm
Pedestal in concrete grade M25	6.25 N / sq.mm
Pedestal in concrete grade M30	7.5 N / sq.mm

The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A coefficient of friction of 0.30 shall be used in conjunction with the minimum column load as defined above. If the horizontal shear force exceeds the

frictional resistance force or if the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.

Welding shall be used for fabrication and erection. Site connections shall generally be with welding. However, high Strength Structural (HSS) bolts shall be used for all important connections to be decided during detail engineering stage. In few cases, for shear connections or removable beam connections, bolted joints with MS bolts may be adopted. 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.

9.3 Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

9.3.1 Vertical Deflection

a) For beams supporting dynamic equipment	: Span / 500
b) For beams supporting floors / masonry	: Span / 325
c) For beams supporting pipes	: Span / 400
d) For roofing and cladding components	: Span / 325
e) For gratings and chequered plates	: Span / 200 subject to a maximum of 6 mm
f) Coal/ Ash conveyor gallery bridges	: Span / 450
g) For beams directly supporting drive machinery	: Span / 500

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

a)	For manually operated cranes & monorails	: Span / 500
b)	For electric overhead cranes	
	i) Up to 50 t capacity	: Span / 750
	ii) Over 50 t capacity	: Span / 1000
c)	The vertical deflection of metal deck sheet for floor / roof shall be limited to	: Span / 250.

9.3.2 Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

a)	Single storey building (without crane load)	: Height / 325
b)	Multistoried building	: Height / 500

	(without crane load)		
c)	Pipe rack columns	:	Height / 325
d)	Crane gantry girder due to surge	:	Height/200
e)	Building main columns at crane rail level due to action of crane surge load only		Height / 2500 limited to maximum of 10 mm
f)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height/4000 limited to maximum of 10 mm
h)	Coal handling trestles	:	Height / 1000 (across conveyor) Height / 500 (along conveyor)

Provisions of IS: 800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

9.4 Minimum Thickness of Structural Steel Elements

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

a)	Trusses, purlins, girts and bracing	6mm
b)	Columns and beams	8mm
c)	Gussets	8mm
d)	Stiffeners	8mm
e)	Base plates	10mm & above
e)	Chequered plates	8 mm o/p & above
f)	Grating flats	5 mm
g)	Latticed structures in switchyard	: 6 mm

Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

Minimum thickness of structural members other than gratings directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

9.5 Minimum Sizes

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other

member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

9.6 **Slenderness and Depth Ratio**

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS:800.

The following limiting ratios of depth to span shall be considered as a general guide.

a) Truss	1 / 10
b) Rolled beams and girders for ordinary floors and rafters	1 / 24
c) Supporting floor beams for vibrating machinery / equipment	1 / 15
d) Roof purlins and girts	1 / 45
e) Gable columns	1 / 30

9.7 **Joints / Connections in Steel Structures:**

9.7.1 Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:9595, IS:1367, IS:9178 and IS:816 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. Where fillet weld is not possible, full penetration but weld shall be provided.
 - ii) For rolled sections and built-up I sections, 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 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 6 mm.
- c. Shear connections shall be designed for 75% of section strength (shear capacity) for rolled sections and 80% of section strength (shear capacity) of built-up section or rolled section with cover plates. However, if actual shear load is more than above, the connection shall be designed for actual load.
- d. Moment connection between beam and column shall be designed for 100% of moment capacity of the beam section. This can be achieved either by direct butt welding of the top and bottom flange of beam with column flange or by providing top and bottom moment plate with suitable notch for additional weld length.

- e. All bolts and nuts shall have property class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS:6755. The threaded portion of the bolt shall project through the nut at least by one thread.
- f. Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.
- g. All butt welds shall be full penetration butt welds.
- h. 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 Purchaser. Bearing edges of crane girders shall be machine finished.
- i. Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.
- j. 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 nominal cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plates.

9.7.2 All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and handrailing shall be made with 20 mm diameter threaded fasteners conforming to IS:1363. Erection bolts shall be black bolts of minimum 12 mm dia.

9.7.3 Efficiency of site welds (fillet/butt) to be considered shall be as follows:

- a) Weld above 20 m from ground --- 50%
- b) Weld below 20 m from ground --- 80%

9.8 Painting

- a. All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.
- b. Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS05-5900 . Primer paint shall be zinc silicate of

approved brand . Dry film thickness of each primer coat shall be 25 microns.

- c. Finish paint shall be 2 coats of matt finish synthetic enamel paint are equivalent with DFT of 25Micron each. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 100 microns. All paints shall be of approved brand and shade as per the OWNER's requirement.
- d. Joints to be site welded shall have no paint applied within 100 mm of welding zone.

Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

- e. Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted.

9.9 Fabrication of Structural Steel Work

9.9.1 The details of fabrication, shop testing and delivery to site of structural steel work including supply of all consumable stores, bolts, nuts, washers, electrodes and other materials as required including field connections are indicated below to be performed by the contractor:

- a. Preparation & submission of complete detailed fabrication drawings and erection marking drawings as required including design calculations.
- b. Furnish all materials, labour, tools & plant and all consumables required for fabrication and supply of all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections.
- c. Furnish shop painting of all fabricated steelwork as specified.
- d. Suitably mark, bundle and pack for transport all fabricated materials.
- e. Prepare and furnish detailed bill of materials, dispatch lists (including bought out items) as required for fabrication of structural steelwork.
- f. Load and transport all fabricated steelwork to site with field connection materials.
- g. Maintain a fully equipped fabrication shop at site for modification and repairs as required.

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

9.9.2 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. The method of painting, marking, packing and delivery of all fabricated materials shall be as approved by the Engineer.

9.9.3 Materials to be used

Standard structural steel sections shall be used instead of fabricated steel sections as far as possible.

- a. All steel materials required for the work shall be supplied by the contractor. All steel materials shall comply with the following IS:-
 - i) IS:801 - Cold formed light gauge steel structural member.
 - ii) IS:2062 - Grade – A, Structural Steel for plate thickness upto 20mm
 - iii) IS:2062 - Grade – B (Killed), Structural Steel for plate thickness above 20mm
 - iv) IS:2062 - Grade – C, for crane gantry girder in turbine hall.
 - v) IS:806 - Steel tubes in general building construction.
- b. Electrodes

The arc welding electrodes shall conform to the relevant IS; and shall be of heavily coated type having uniform thickness. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (polarity in case of D.C. supply) for which the electrodes are suitable. All electrodes shall comply with the following IS:

- i) IS: 814 - Covered electrodes for metal arc welding structural steel
- ii) IS:815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- iii) IS:7280 - Base wire electrode for submerged arc welding.
- c. Bolts and nuts

All bolts and nuts shall conform to the requirements of IS:1367 - Technical Supply Conditions for Threaded Fasteners. Materials for bolts and nuts shall comply with the following IS codes. Mild steel for bolts and nuts tested to following IS shall have a tensile strength of not less than 44 Kg/mm²; and minimum elongation of 23 per cent on a gauge length of 5.6 Å, where 'A' is the cross sectional area of the test specimen :

- i) IS:1367 - Technical supply conditions for threaded fasteners.
- ii) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

- iii) High tensile steel material shall have the mechanical properties as per IS:1367 or as approved by the Engineer.

d. Washers

Washers shall be made of steel conforming to the following IS:

i)	IS:1977	-	Structural steel (Ordinary Quality) St-39-0
ii)	IS:2062	-	Steel for general structural purpose
iii)	IS:6623	-	High Strength Structural Nuts
iv)	IS:6649	-	Hardened and tempered washers for high strength structural bolts & nuts.

9.10 Storage of Materials

- a. All materials shall be stored to prevent deterioration ensuring 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. The contractor shall maintain upto date account 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 shall be stacked separately with easily identifiable marks.
- b. The steel used for fabrication shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials should be stored under cover and suitably painted for protection against weather.
- c. 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].
- d. Bolts, nuts, 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.
- e. Paints shall be stored under cover in airtight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

9.11 Inspection of Fabrication Work

As far as possible, all inspections by the Engineer shall be made at the contractor's fabrication shop. The contractor shall co-operate with the Engineer in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools & plant, 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 would be rejected at any time during the progress of the work.

The dimensions, forms, weights and tolerances of all rolled shapes, bolts, nuts, studs, washers etc. and other members used in the fabrication shall, wherever applicable, conform to the requirements of the latest relevant IS.

9.12 Fabrication Drawing

The sequence of submission of fabrication drawings for approval shall match with the approved fabrication and erection schedule. It should be ensured that the correctness of general arrangement for centerline dimensions and levels, section sizes, and adequacy of connections including splice joints as to the number of bolts, weld length, size of gusset/end plates are maintained. 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 spec.

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

- i) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- ii) Dimensional drawings of base plates, foundation bolt location etc.
- iii) Details of all connections with supporting calculations.
- iv) Any other drawings or calculations that may be required for the clarification of the works.

The fabrication drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication 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 fabrication 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 fabrication 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 IS:813; and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

9.13 Workmanship

- a. All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of IS:800 and other relevant Indian standards or equivalent.
- b. 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 IS:1852. If straightening is necessary, it shall 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.

- c. Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch is permitted for mild steel only. Gas cutting of high tensile steel is 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 shall be permitted if special care is taken and done under expert hand.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, subjected to substantial stress or which have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gouges 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.

- d. Finishing of sheared or cropped edges of plates or shapes of edges gas-cut with 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.
- e. 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.
- f. Bolted construction:
- i) 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 shall 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 black bolts shall be not more than 1.5 mm or 2 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 to IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thicknesses 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.

- ii) 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 to 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 connection as may be specified.

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 indicated on the drawings.

g. Welded Construction

- i) Welding shall be in accordance with relevant IS. Welding shall be done by experienced and good welders qualified by tests in accordance with IS:817. Surfaces 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.
- ii) 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.
- iii) 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 shall be made by shop splicing not more than 3 sub-sections, each made in accordance with this paragraph. Welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant IS.

- iv) 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 joint in a manner ensuring soundness. Where possible, this should be done by use of extension bars or run-off plates which need not be removed upon weld completion. 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 conform to the relevant IS.

- v) If welding is to be undertaken at low temperature, adequate precautions as recommended in relevant IS shall be taken. 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°C, all requirements regarding preheating of the parent material shall be in accordance with the relevant IS.
- vi) Where required, intermediate layers of multiple-layer welds shall be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld is cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld & base metal from over peening.
- vii) The equipment shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of type and capacity as recommended by the electrode manufacturer.
- viii) Column splices and butt joints of compression members for stress transmission shall be accurately machined and close-butt 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 mm.
- ix) Bases and caps fabricated out of steel plates, 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. The ends of lacing bars shall be neat and free from burrs. 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. Provision shall be made for all necessary steel bearing plates to take up reaction of beams & columns and the required stiffeners & gussets whether or not specified. Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

- x) All shop connections shall be welded as specified. Certain shop connections, may be changed to field connections if desired by the Engineer for convenience of erection; and the contractor shall make the desired changes. The steelwork shall be temporarily shop-erected complete so that accuracy of fit may be checked before dispatch. 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 facilitating the check of interchangeability.

9.14 Testing, Acceptance Criteria and Delivery

- a. The contractor shall carry out testing as per IS. The contractor shall get the specimen tested in a laboratory approved by the Engineer and test results shall be submitted to the Engineer in triplicate within 3 days after completion of the test. All electrodes shall be procured with test certificates. The correct grade and size of electrodes not deteriorated in storage shall only be used. The testing of welding shall be performed as under with quantum of minimum non-destructive tests to be conducted during fabrication and after erection as below:
 - i) Ultrasonic test should be performed on the columns, girders, Built-up beam fabricated with plates.
 - ii) Fillet welds at junction of flange & web of built-up beams, columns, all shear connections of main beams and all butt welds shall be 100% ultrasonic tested
 - iii) 100% radiographic test shall be performed for butt weld joints of crane girder & its supporting columns, deaerator supporting beams and columns. The minimum percentage of Radiographic test to be carried out at other locations shall be 25 percent.
 - iv) Dypenetration test, Ultrasonic test, Radiographic test shall be carried out at any other location also, if required as per Engineer's approval.

In cases, the test results shows deficiency, the Engineer shall have option to reject or instruct any remedial measures to be carried out by the contractor.
- b. All bolts, nuts and washers shall conform to the relevant IS. If desired by the Engineer, representative samples of these materials should be tested in an approved laboratory and in accordance with the procedures

described in relevant IS. All paints and primers shall be of standard quality and shall conform to the provisions of the relevant IS. The tolerances on the dimensions of individual rolled steel components shall be as per IS:1852. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as per IS:7215.

- c. Should any structure or part of a structure be found not to complying to the provisions of the 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 have been successfully carried out, the steelwork will be accepted forthwith; upon receipt of which, the items shall be shop painted, packed and dispatched. No item should 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 Purchaser to accept the work, should it, on further tests before or after erection, be found not in compliance with spec.

- d. The contractor should deliver the fabricated structural steel materials to site with all necessary field connection materials in a sequence permitting an efficient and economical performance of the erection work. The Purchaser may prescribe or control the sequence of delivery of materials, at his own discretion. 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.

9.15 Rectification of Defects in Welds.

In case of detection of defects in welds, the rectification of the same shall be done as follows:

- i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.
- ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc., exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch wheel. Care shall be taken not to damage the adjacent material.

9.16 Erection of Structural Steel Work



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- 9.16.1 The works related to the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete are detailed below:
- a. Providing all construction & transport equipment, tools, tackles, consumables, materials, labour and supervision as 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.
 - c. Transportation of all fabricated structural steel materials from site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation in proper location as per approved erection drawings. If necessary suitable temporary approach roads should be built for transportation.
 - d. Checking centerlines, 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, leveling, bolting, welding and securely fixing the fabricated steel structures as per drawings.
 - f. Painting of the erected steel structures.
 - g. Minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-
 - 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.
 - 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 drilled in incorrect location during fabrication.

- 9.16.2 The work shall conform to the latest revisions of the following IS Codes:



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



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-12840	: Tolerance for erection of Steel Structures

9.16.3 Conformity with designs:

The contractor should erect the fabricated steel structures, align all the members, complete all field connections as per approved drawings. All works shall conform to the provisions of the relevant IS. The testing and acceptance of the erected structures shall be in accordance with the provisions of this specification.

9.16.4 a. The contractor should take delivery of all the materials at site. He shall unload the materials and perform all formalities such as checking of materials and attend to insurance matters as specified above.

Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the contractor's own cost. All field connection materials such as bolts, nuts, washers and electrodes, other consumables such as oxygen and acetylene gas, paints, fuels, lubricants, oil, grease and any other material as required for the execution of the works shall be supplied by the contractor for erection work.

b. All materials shall be stored preventing deterioration and ensuring 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. The contractor should establish a suitable yard at site for storing the fabricated steel structures and other materials. The yard shall have proper facilities such as drainage, lighting, suitable access for large cranes, trailers and other heavy equipment. 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. 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.

c. The contractor shall establish and maintain quality control procedures for different items of work and materials; and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following:

- i) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

9.17 Workmanship

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

most economical method; and sequence available to him consistent with the drawings.

- b. 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.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure during the course of the erection of the steel framing, arrangement for 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, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer. The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the erection

- c. Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be as per approved drawings. Anchor bolts and other anchor steel shall be embedded. 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, the contractor shall set proper screed bars 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. No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.
- d. All relevant portions in respect of bolted construction for fabrication of structural steelwork shall also be applicable for field bolting as below:

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 light 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. High tensile bolts shall be tightened to provide the required minimum bolt tension by any of the following methods:-

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 as below 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.

Bolts shall 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 shall be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

Torque Wrench tightening: When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques as below. 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.

Nominal bolt diameter (mm)	Torque to be applied for bolt class 8.8 of IS:1367 (Kgm)
20	59.94
22	81.63
24	103.73

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 shall 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 as per IS.

- e. Field Welding: All field assembly and welding shall be carried out as specified for fabrication work, 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.
- f. Holes, cutting and fitting: No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done. 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. 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.

9.18 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock shall be considered as permissible. For this, light drifting shall 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 shop work error 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.

9.19 Load Test and Acceptance Criteria

- a.) Loading tests shall be carried out on erected structures 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 be dismantled and replaced with suitable member. On the basis of the tests, the Engineer will decide and his decision will be final. 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

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 below:-

- i) 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 per cent of the maximum increase in strain or deflection recorded during the second test.

- ii) **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 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.

- b.) **Structure of same design:**

Where several identical same design structures exists as a prototype, one structure shall be fully tested, 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.

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 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.

- c.) **Repair for subsequent test and use after strength tests:** The structure passed the "Strength Test" as above 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 above.

9.20 Tolerances

Considering expected variation in the finished dimensions of structural steel frames, these shall be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabrication tolerances for the finished parts; and the rolling tolerances for the profile dimensions permitted under the specification for fabrication of structural steelwork shall be as indicated below:

	Component	Description	Variation Allowed
a	For Buildings Containing Cranes		
	i) Main Column	a) Shifting of column axis at foundation level	

Component	Description	Variation Allowed
	with respect to building line	
	i) In longitudinal direction	(+/-) 3.0mm
	ii) In lateral direction	(+/-) 3.0mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
	i) For a column upto including 10M	(+/-) 3.5 mm and from true height vertical
	ii) For a column greater than 10M but less than 40M height	(+/-) 3.5 mm from true vertical for length measured between connection levels, but not more than (+/-) 7.0 mm per 30 m length
	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 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
ii) 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
	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.
iii) Cranes Girders & Tracks	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b) Deviation to crane rail gauge	(+/-) 3 mm

	Component	Description	Variation Allowed
		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
	iv) 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 Deg.C per unit length.	
b	For Buildings without Cranes		
	The maximum tolerances for line and level of the steel work shall be $\pm 3\text{mm}$ on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 m section of height and not more than 7 mm per 30 m section. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.		

9.21 Quality Control Procedure.

The contractor shall establish & maintain quality control procedure for different items of works and material to ensure that all works are performed as per specification.

Contractor shall get approved field quality plan for all the works to be executed

Quality plan shall be prepared based on guide lines furnished in Volume-II of the specification.

10.0 REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS

10.1 General

All structures, building foundation, machines / equipment foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS: 3370 for normal and water retaining structures respectively

10.2 Design Methodology

- a) The design and construction of RCC structures shall be carried out as per IS: 456-2000. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.
- b) For all concrete structures, ductile detailing has to be done as per IS: 13920 and IS: 4326.
- c) For reinforcement detailing, IS: 5525 and SP34 shall be followed.
- d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150mm or more.

10.3 Foundation and Underground structures

- a) Foundation system to be adopted for structures shall be based on loading arrangement, load intensity and soil strata.
- b) All RCC liquid retaining shall be designed as uncracked section for water face and cracked section with crack width limited to 0.1mm for earth face in accordance with IS:3370 (Part 1 to 4) by working stress method, using limited steel stress. For all other underground structures such as conveying structures / slurry pump house/ pump houses / under ground structures such as tunnels, reclaim hopper pit, not in contact with liquid on inside face may be designed as cracked sections with crack width limited to 0.1mm for both faces.
- 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 rectified by chemical injection grouting through nozzles.
- d) Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.
- e) In all liquid retaining structures, pvc water bar shall be provided at each construction / expansion joint. No pressure relieving devices shall be permitted in underground structures except forebay.
- f) For design of all underground structures, including CW ducts, pump house and forebay etc. ground water table shall be assumed at the finished ground level unless specified otherwise. In addition to ground

water pressure, minimum surcharge load of 2 T/M^2 shall also be considered for design of all underground structures.

- g) All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factor of safety for these cases shall be as per IS:456 and other relevant IS codes. However, following minimum factor of safety shall be followed,
 - a) Factor of safety against overturning due to wind , seismic or other lateral load shall be 1.5 minimum.
 - b) Factor of safety against sliding shall be 1.5 minimum.
 - c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.
- h) In cases where dead load provides the restoring forces, only 0.9 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.
- i) In case of open foundations, loss of contact of foundations (including machine foundations) at founding level shall not be allowed for any combination of loads in the design of any foundation under the scope of this package.

10.4 Grouting

- i) Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength flowable ready mixed non-shrink grout shall be used.
- ii) Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.
- iii) Nominal thickness of grouting shall be atleast 50 mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25 mm thick.

10.5 Edge Distance For Bolts

Minimum distance from the center line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

- i) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 100 mm.
- ii) Clear distance from the face of pocket to the outer edge of pedestal shall be 100 mm.
- iii) Clear distance from the edge of the embedded part of the bolt assembly to the outer edge of pedestal shall be 100 mm.

10.6 Loading conditions for underground structures

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.

- a. Water pressure from inside and no outside pressure, like earth pressure, ground water & surcharge pressure (applicable only to structures which are liable to be filled up with water or any other liquid.)
- b. Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
- c. Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves / flap valves, etc. may be considered only in forebay of CW Pump House to counter the buoyancy. When pressure relief valves are used, 50% of the hydrostatic pressure shall be considered for design of the base slab.
- d. Base slab of the pump houses shall also be designed for the condition of different combination of pump sump being empty during maintenance stages with maximum ground water level.
- e. 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.
- f. 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.

10.7 Machine Foundations

Turbo- Generator (TG) foundation:

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 to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

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 either with open or pile foundation.

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 either with open or pile foundation. The vertical faces 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.

General requirement for machine foundations:

- The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbogenerators,
- 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.
- 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 near by structures / foundations.
- 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.

10.7.1 a) Design of Foundation for TG, TDBFP, MDBFP & Fan foundations

(i) 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.
- 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 and 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 Coal Mills and Crushers shall be as specified elsewhere in this specification.

(ii) 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.

Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. However, frequency separation criteria and amplitude criteria as laid down in IS:2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied.

For all equipment foundations supported on VIS system, the stiffness of the supporting substructure shall be at least ten (10) times that of spring elements as per DIN 4024.

Bidder to consider the acceleration at the top of the deck for the design of supporting / fixing arrangement of machine.

(iii) 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.

(iv) 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.

(v) 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 RCC block shall be at least three times the mass of machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%. 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).

- 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.

Steel Helical Springs And Viscous Dampers

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 prestress, alignment, commissioning, etc. of Steel helical springs and viscous dampers.

The Steel helical springs and viscous dampers supplied should be of proven make.

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 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

j) 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.

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.

- (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.

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.

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.

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”.

Supervision

The supervision of installation of Steel helical springs and viscous dampers including prestressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.

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.

Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096.

Following acceptance criteria shall be followed:

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.

10.8 Increase in Stresses

10.8.1 Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design.

10.8.2 Bearing capacity of the soil / pile capacity shall be allowed to increase by 25% under seismic / wind load condition except for chimney where increase in bearing capacity/pile capacity is not considered.

10.9 Minimum thickness of structural elements:

The following minimum thickness shall be followed:

Flat roof slab	:	125 mm
Suspended floor / slab / walkways / canopy slabs etc.	:	150 mm
Ground floor slab (non-suspended)	:	150 mm
Water retaining slabs / walls	:	200 mm
Cable / pipe trenches / underground pits / Launder walls and base slab	:	125 mm
All footings (including raft foundations)	:	300 mm
Parapets	:	125 mm
Sunshades at edge	:	75 mm
Pre-cast louvers / fins	:	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	:	75 mm
Paving	:	150 mm
Basement walls and base slab	:	200 mm
Silo / bin walls	:	150 mm

Underground reservoir	:	
Below ground	:	200 mm
Above ground	:	150 mm

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig. 1 or table 16a of IS:456.

10.10 **Minimum Concrete Clear Cover and Minimum Diameter of Reinforcement :**

10.10.1 The minimum concrete clear cover to Reinforcement bars in all RCC structures shall be as per Fig 1 of Table 16 & 16 A of IS 456.

However in no case the clear cover shall be less than that stipulated below:

	Top	Bottom	Side	Ends
Sub Structure Works:				
i) Foundation	50	50	50	-
ii) Columns, Pedestals			50	50/75*
iii) Grade Beam/Tie Beam	40	40	40	-
iv) Trenches & pits etc. in contact with earth or/and water	30	30	30	-
v) Slab-on-Grade	30	30	50	-
vi) Base Raft	50	75	50	-
vii) Others	30	30	40	-
viii) Pile Cap	50	100	50	-
Super Structure Works:				
i) Columns	-	-	40	50
ii) Beams	25	25	25	50
iii) Slabs	20	20	30	-
iv) Lintel, Bands etc.	25	25	25	-
v) Precast Concrete	20	25	25	-
vi) Others	25	25	25	-

10.10.2 Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows::

Sl. no.	Structural Element	Main Reinforcement	Distribution Reinforcement/ Anchor Bars
a)	Foundation	16 mm	12 mm
b)	Pile Cap	16 mm	12 mm
c)	Beams	12 mm	10 mm
d)	Columns	12 mm	--
e)	Pits/Trenches	12 mm	10 mm

Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c/c.

10.11 Minimum Height for Pedestals / Encasement of Steel Columns/Wall Beams

10.11.1 Pedestals to steel columns for building structures

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following:

- a. Open area : 300 mm above paved level
- b. Covered area : 300 mm above FFL

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

All wall beams shall be provided with gunniting of 50 mm thick around with nominal reinforcement and chicken mesh.

10.11.2 Pedestals to steel columns for equipment structure:

- a. Equipment in open area : As required (300 mm min.)
- b. Equipment in covered area : As required (150 mm min.)
- c. Structures and equipment supplied by vendor : As per vendor's data subject to minimum as specified above.

10.12 The number of construction joints in the columns of steam turbine foundation shall be restricted.

Construction joints at the following two (2) locations shall be provided:

- a) At the meeting points of the columns and the raft.

- b) At the meeting points of the column and the top deck.

Additional reinforcement and shear keys shall be provided at the construction joints.

The base raft for steam turbine and GT foundation and table top for steam turbine shall be cast in single pour.

10.13 Concrete Mix

The following minimum grades of concrete as per IS:456 shall generally be used for the type of structures noted against each grade.

a.	Grade M15	:	Fill concrete
b.	Grade M10	:	Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 75 mm.
c.	Grade M25	:	Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work, grade slab & grade beams etc.
d.	Grade M25	:	All RCC members, e.g. foundation and superstructure of all plant and non-plant buildings, pedestals, roof slabs, cable and pipe trenches,
e.	Grade M30	:	TG foundation, Chimney raft, Shell & Superstructure, Pre-cast plank, RCC road, Natural Draft Cooling Tower, Ash silo including foundation, Crusher foundation including top deck, all fan foundations, Mill foundations, all water / liquid retaining structures / pits / sumps / basins including Pump Houses, cooling water channel, CWPB forebay, raft & sump etc..
f.	Grade M35	:	TG top deck

For superstructure of RCC chimney and induced draft cooling towers richer mix may be used as per design requirement. However, requirement of Table-4 & 5 of IS: 456 shall be satisfied as per the exposure condition. As per IS:456, exposure condition will be **“severe”** for all structures under the civil scope of work.

10.14 Allowable Settlement

The total permissible settlement and differential settlement of the foundations will be governed by IS: 1904, IS: 13063 and from functional requirements whichever is more stringent.

Maximum allowable total settlement should be restricted to 25 mm for foundations of all plant structures like cooling towers, CW pump house, DM

plant, crusher house, transfer house, Power House, TG foundation, Mill foundations, Fan foundations, Crusher foundation etc.,

Maximum allowable total settlement should be restricted to 40 mm for all other foundations.

All foundations shall be so designed that the settlements are within permissible limits as per relevant Indian Standard or from consideration of safe equipment / machine operation whichever is critical. In case of open foundations without piles, Ground improvement methods opted by contractor, like sand drains / stone columns etc. to reduce settlement and increase the rate of settlement, detail methodology of such installation supported by calculation based on relevant field data shall be furnished for approval of Owner / Consultants before execution. However, type of foundations (open type or pile) shall be as per approved soil investigation report and the specific requirements mentioned Chapter-5 of this Specification. Similarly, ground improvement shall also be as per recommendation of approved soil investigation report. In the event, the contractor adopts any patented method of ground improvement or retain any specialized agency for such purpose, the same can be done subject to prior approval of owner.

Boiler and ESP support structures shall be checked for differential settlement of foundations which shall be restricted to 1 in 1000 of span or 8 mm whichever is less.

10.15 AFTER AWARD OF WORK ACTIVITIES

- a) This part covers the requirements for general use of Plain and Reinforced Cement Concrete work in structures at all locations, cast-in-situ or precast , including all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. The special requirements of structures covered in latest IS:456 should also be complied with.
- b) The works to be provided by Contractor :
 - i) Furnish all labour, supervision services including facilities as required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plant, transportation etc. required for the work.
 - ii) Prepare progressively detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
 - iii) Submit shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.
 - iv) Submit detailed drawings of supports, templates, hangers etc. required for installation of various embedment like inserts, anchor bolts, pipe sleeves, joint seals, hangers, openings, frames etc.
 - v) Submit detailed schemes of all operations required for executing the work e.g. material handling, concrete mixing, placement of concrete, compaction, curing, services, approaches etc.

- vi) Design and submit concrete mix designs required to be adopted on the job.
- vii) Provide all incidental items necessary for successful completion of the work in accordance with the drawings, specifications and schedule of Items.
- ix) Supply of specialized materials as directed by the Engineer with a guarantee in approved performance for satisfactory performance.
- x) Furnish samples and submit for approval the results of various properties of the following materials :
 - a. The various ingredients of concrete including concrete
 - b. Embedments.
 - c. Joint seals.

The following information and data including samples where necessary shall be submitted by the bidder progressively during the execution of contract

a) Programme of execution and Requirement of Materials

Within 15 days of the award of contract ,the Contractor will submit a Master Programme for completion of the work giving month wise requirements of materials , particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the contract.

The 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 emergency of the work.

b) Samples

Materials supplied by the Contractor have to be tested for physical, chemical and other properties in the reputed labs at their cost. If found unsuitable, the same shall be removed from the site. Samples of the following materials & any other materials proposed to be used, shall be submitted as directed by the Engineer in Charge, in sufficient quantities free of cost for approval. Approved samples will be preserved by the Engineer in Charge for future reference. The approval of the Engineer in Charge shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :-

- i) Coarse and fine aggregates.
- ii) Cement
- iii) Reinforcement
- iv) Admixtures
- v) Plywood for formwork
- vi) Embedded & anchorage materials as may be desired by the Engineer in Charge.

- vii) Joint sealing strips and other waterproofing materials.
- viii) Joint filling compounds
- ix) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per the specification giving proportions of the ingredients, sources of aggregates & cement, along with test results of trial mixes as per relevant I.S. is to be submitted to the Engineer in Charge for his approval before it can be used on the works.

- a. Detailed drawings & designs of formworks to be used.
- b. Detailed drawings for templates & temporary supports for embedments.
- c. Test reports for cement, reinforcement steel and formwork including inspection reports.
- d. Any other data as per specification.

d) Test Reports

Following reports are to be submitted by Contractor :

- i) Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.
- ii) Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer
- iii) Reports of tests of various materials and concrete.

e) Conformity with Design

The contractor should prepare check lists in approved performa which will be known as "Pour Cards" listing out all items of work involved. The contractor should inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help & assistance to the Engineer for checking required in the pour. On satisfying himself that all details are in accordance to the drawings & specifications, the Engineer will give written permission 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 should be written on accompanying sheets attached to the Pour Cards. These sheets, termed as "Progress Cards" shall be prepared by the contractor on approved performa. The Pour Cards alongwith accompaniments shall be handed over to the Engineer before starting placement of concrete. One of 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 shall be to Engineer's approval.

10.16 Materials to be Used / Supplied by Contractor

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.

a. Cement

Ordinary Portland Cement (OPC) Grade 43 shall be used for all structures.

For mix design, water cement ratio would not exceed 0.45. Chloride free sulphonated melamine based super plasticizer conforming to IS:9103 shall be added as per mix design and manufacturer's instructions to improve workability.

b. Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm & 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries & conforming to IS: 383 shall be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

c. 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 shall be allowed to be used on works.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading with prior approval of the Owner.

Crushed stone sand alone may be used only with the prior approval of the Engineer for filling and PCC works only.

d. Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts and other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 shall be followed for routine tests. In case of doubt, the acceptance test for water shall be as per IS: 3025 and Table-I of IS: 456.

f. Admixture

Only admixtures of approved quality shall be used when directed or permitted by the Engineer in Charge. The admixture shall conform to IS: 9103.

g. Reinforcement

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 500 conforming to IS:1786- latest.

10.17 Storage of Materials

- a. 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 its otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately. The contractor shall maintain up-to-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.
- b. Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-house at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. Sufficient space of storage with open passages should be arranged between stacks. Cement shall be stored in easily countable stacks with consignment identification marks arranged in the order of their receipts at site. Sub standards or partly set cement shall not be used; and shall be removed from the site, as soon as it is detected.
- c. Aggregates shall be stored on planks or on 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 stockpiles stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from getting intermixed. Stacks of fine & coarse aggregate shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths.
- d. Reinforcing shall be stored consignment –wise and size wise off the ground & under cover. It shall be protected from rusting, oil, grease and distortions. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

10.18 Concrete Mix Requirements

Concrete mix requirements shall be in accordance with IS:456 and as supplemented and modified herein or by other best possible standards.

- a. Washing & Screening of coarse and fine aggregates shall be carried out to remove fines, dirt and other deleterious material.
- b. Admixture: All concrete shall be designed for normal rate of setting and hardening at normal temperature and humidity under different climatic conditions. Admixtures shall be used in accordance with IS:456 to modify the rate of hardening, to improve workability or an aid to control quality. The Engineer reserves the right to order for 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 desired by the Engineer.
- c. Concrete grades to be used in different parts of work shall be as shown on the drawings or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 shall be followed.
- d. Proportioning of ingredients of concrete shall be made either with preliminary test by designing the concrete mix ["Design Mix Concrete"] or without preliminary test adopting nominal concrete mix. Design mix

concrete shall be used on all concrete works while nominal mix concrete, as per IS:456, may be used as shown on drawings and approved by the Engineer. In all cases, the proportioning of ingredients and works control shall be in accordance with IS:456 and its adequacy after obtaining Engineer's approval.

e. **Mix Design Concrete**

Concrete mixes shall be designed by the contractor to achieve the strength, durability and workability economically with various ingredients. In general the design will keep in view the following considerations :

- i) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- ii) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- iii) 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.
- iv) Chemical admixtures may be used to modify the rate of hardening and improve workability.
- v) 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.

vi) **Concrete Mix Design and Strength requirements**

Concrete mix design shall be as per IS: 10262 and SP: 23. 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.

f. **Minimum cement content**

The minimum cement content for each grade of concrete shall be as per Table 1.

TAB L E - I MINIMUM CEMENT CONTENT & MAX. W / C RATIO SPECIFIED FOR DIFFERENT GRADES OF CONCRETE

Sl. no	Conc Grade	Min cement content (kg / cum)	Water, Cement ratio	Slump (mm)
1	M 10	-	-	-
2	M 15	250	0.5	-
3	M 20	320	0.55	80+/-20
4	M 25	365	0.50	Do

5	M 30	365 - 400	0.45	Do
6	M 35	425	0.45	Do
7	M 40	425	0.40	Do

The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

g) Water-Cement Ratio

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

- i) The requirement of strength.
- ii) The requirement of durability.

i) Strength Requirements of Concrete Mix

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS: 456 will be selected by trial and error. The values of water- cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer.

Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-9 of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

ii) Durability

Tables 4 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

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.

h. 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 embedment's 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 limits of consistency for various types of structures as per Table – I

With the permission of the Engineer. For any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7 of IS: 456 shall be carried out.

i. 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 RCC foundations	-	40 mm
Mass concrete	-	80 mm
Mass concrete in very large structure	-	150 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles 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

j Mixing of Concrete

Controlled concrete only in batching plant shall be used for all major and minor works including power house column foundation, TG, boiler foundation, ID, FD, PA, BFP foundations, chimney cooling tower & other important structure.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time, the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Purchaser to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 should be allowed to be employed. Batching Plant where used shall conform to IS: 4925.

Hand mixing if permitted shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Purchaser.

Crushed ice shall be used in concrete mixing water so as to maintain temperature in the concrete in the top decks of the machine foundations. Arrangements for standby weight batching plant and equipment shall also be made available by the contractor for continuous pour of concrete.

k. 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, concrete shall be placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way preventing segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design should be used. If, inspite of all precautions, segregation does occur during transport, the concrete shall be properly remixed before placement. During very hot weather, concrete shall be transported in deep container to reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container should be covered. Conveying equipment for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete.

l. Placing and Compacting of Concrete

- i) Relevant I.S. Code should be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. Concrete shall be placed against the surfaces of formwork or construction joint in concrete or masonry. The surface against which concrete is placed shall be cleaned thoroughly. 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. shall be removed by air water jetting or water at high pressure.

Concrete shall be placed in the formwork by approved means, and shall not be dropped from a height or handled in a manner which may cause segregation.

- ii) Construction joint shall be kept moist for atleast 72 hours prior to placement.

Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution shall be adopted. Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

- iii) 12 mm thick mortar with less w/c ratio as that of the concrete being placed and cement slurry shall be spread thoroughly on the construction joint just prior to placement of concrete. The concrete shall be spread, and thoroughly compacted 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. In thin members with heavy congestion of reinforcement of other embedments, where effective use of internal vibrator is, doubtful, in addition to immersion vibrators, the contractor should employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor should employ screed vibrator as per IS: 2506. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

- iv) The rate of placement of concrete shall be such that no cold joint is formed; and fresh concrete is placed always against green, plastic and workable concrete. No concrete shall be placed in open during rains. During rainy season, no placement in the open should be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at 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.

- v) Slabs, beams and similar members shall be poured in one operation. Moulding, throating, drip course, etc., shall be poured as per the drawings. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as per drawings. 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 disturbed.

10.19

a) Construction Joints



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Concrete structure shall be completed 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 shall be formed as per drawings. Vertical construction joints shall be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. For water retaining structures and leak proof buildings suitable and approved water stops shall be installed at the construction joints as per clause 12.4 of IS:456. Where the location of the joints are not specified, it shall be in accordance with the following :-

- i) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- ii) 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 at the middle of the span.
- iii) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- iv) Feather-edges in concrete shall be avoided while forming a joint.
- v) A construction joint should preferably be placed in a low stress zone and at right angles to the direction of the principal stress.
- vi) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

b. 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 :-

- i) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete should be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible, and the joint thoroughly and systematically vibrated.
- ii) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall 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, shall be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

- iii) In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise inspite of extensive vibration, the joint shall be left to harden for atleast 12 to 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as indicated above.

c. Expansion And Isolation Joints

- i) Expansion and isolation joints in concrete structures shall be provided at specific places as shown on the drawings with materials and types of joints as specified. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as specified on the drawings. All materials should be procured from reliable manufacturers to the approval of the Engineer. Test certificates for the materials should be furnished. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval from concerned engineer of the method of forming the joints should be obtained.

- ii) Duraboard HD or its equivalent of approved manufacturer shall be used as filler 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 recommended by the manufacturer.

Commercial quality of expanded polystyrene products commonly used for thermal insulation can also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material should be procured from reliable manufacturers as approved by the Engineer. The method of installation shall be similar to that recommended by the manufacturer for fixing on walls. A coat of bitumen paint shall be applied on the board against which concrete is placed.

- iii) Joint sealing strips shall 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. General strips shall be of PVC or otherwise as specified. Sealing strips shall not have any longitudinal joint; and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material shall 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. The contractor should supply all labour and materials for installation including the material and tools required for jointing, testing, protection, etc. The joints in rubber seals shall be vulcanised as needed.

- iv) The minimum thickness of P.V.C. sealing strips shall be 3 mm and the minimum width 100mm. The actual size and shape shall be as shown in drawings. The material should be of good quality Polyvinyl Chloride highly resistant to tarring, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows:
- i) Specific Gravity : 1.3 to 1.35
 - ii) Shore Hardness : 60A to 80A
 - iii) Tensile Strength : 10 to 15 N/Sq.mm
 - iv) Maximum Safe Continuous Temperature : 70 Deg.C
 - v) Ultimate Elongation : Not less than 275%
- v) Bitumen Compound: When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound Manufacturer's recommendation. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.
- vi) Isolation Joints: Strong and tough alkathene sheet or equivalent, about 1 mm in thickness 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.
- vii) 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. The rubber shall have a unit weight of 1500 kg/cum, 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.
- viii) All foundation structures in contact with soil shall be coated with two coats of Bituminous coating.

10.20

Repairs, Finishes and Treatment of Concrete Surfaces

- a. Adequate and sound concrete surfaces, whether formed or unformed, should be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.
- b. Unsound concrete resulting from improper mix design, incompetent methods, equipment and form work, poor workmanship and protection shall not be accepted and shall be dismantled, removed and replaced by sound concrete at the contractor's cost. All concrete work shall be inspected by the contractor immediately after the forms are removed and he should promptly report of occurrence of any defects to the Engineer. All repair works should be carried out as per the instructions and in the presence of the Engineer. Generally, repair work shall consist of any or all of the following operations :

- i) Sack rubbing with mortar and stoning with carborundum stone.
- ii) Cutting away the defective concrete to the required depth and shape.
- iii) Cleaning of reinforcement and embedments.
- iv) Roughening by sand blasting or chipping.
- v) Installing additional reinforcement/ welded mesh fabric.
- vi) Dry packing with stiff mortar.
- vii) Plastering, guniting, hotcreting etc.
- viii) Placing and compacting concrete in the void left by cutting out defective concrete.
- ix) Grouting with cement sand slurry of 1:1 mix.

c. Finishing Unformed Surface

The requirement of finishes of formed surfaces are specified hereunder separately. The contractor should include for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below :

- i) Floor: For non-integral floor finish, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and 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. The surface shall be scored and marked to provide better bond.

For monolithic finish, 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 should then started after the moisture film & shine 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 should 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 should 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 floor should be marked in a regular geometric pattern after initial trowelling.

- ii) Beams, Columns & Walls: If on any other concrete structure, it is intended to apply plaster or such concrete surfaces against which brick- work 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.

- d. Protection and Curing of concrete: Newly placed concrete shall be protected 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. Steps 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, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the contractor.

The contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. In case any lapse on the part of the contractor is noticed, the Engineer will inform the contractor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the contractor within 3 hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the contractor.

10.21 Reinforcement

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 500 conforming to IS:1786 – latest.

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

b.) Bar Bending Schedules

The contractor shall submit to the Engineer bar bending schedules with working drawings showing clearly the arrangements proposed by the contractor. Upon receipt of the Engineer's final approval of the bar bending schedule and drawings, the contractor shall submit the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings shall not relieve the contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contractor.

c.) Bending

Reinforcing steel shall be bent in accordance with the procedure specified in IS:2502. Bends and shapes shall comply strictly with the dimensions corresponding to the approved bar bending schedules which 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. Re- bending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent.

d.) Placing in position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings. Bars at crossing points, shall be securely tied together by # 20G annealed soft iron PVC coated wire or by tack welding in case of bar larger than 25 mm dia. 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 with FBEC 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.

e.) Welding

Normal bond laps in reinforcement should be placed by lap or butt welding reinforcement bars. The work should be done with suitable safe guards as per IS for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics to IS:566 shall also be as per drawings.

f.) 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 as per IS: 456. 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. 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. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1part cement to 2 parts sand by volume and cured in a pond for at least 14 days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

g.) Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 4.5 Deg.C or below during the placing and curing period, the work shall conform to the requirements of clause 13 of IS: 456 and IS: 7861.

h.) Hot Weather Concreting

When depositing concrete in very hot weather, the contractor shall take all precautions as per IS: 7861 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 38oC while placing.

10.22

Form Work



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- a. The contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centering. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings. 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.
- b. The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakes shall 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. 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 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. Bolts passing completely through liquid retaining walls/ slabs for the purpose of securing and aligning the formwork shall not be used.

- c. 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 meters span. Bevelled forms 25 mm x 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 as necessary. 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.

- d. 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 or other compound 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.

e. Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

f. Inspection of Forms

Casting of concrete shall start only after the formwork inspection and approval by the Engineer. The concreting shall start as early as possible within 3 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.

g. 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 the date on which concrete is placed in each part of the work; and the date on which the formwork is removed there from. 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. Forms for various types of structural components shall not be removed before the minimum periods as detailed below:-

Schedule of Removal of Form Work

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement			
	Temperature (°C)				Temperature (°C)			
	Above 40oC	40o-C to 20oC	20o to 5oC	Below 5oC	Above 40oC	40o-C to 20oC	20o to 5oC	Below 5oC
	Days	Days	Days	Days	Days	Days	Days	Days

a) Columns & Walls	2	1	1	Do not remove forms until site cured test specimen	1	1	1	Do not remove
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs 125 mm	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 40oC can be reduced to those of the temperature range of 20oC to 40oC.

ints in beams shall be located at the middle of span. 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.

h. 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 :-

- i) Sectional dimension - +/- 5 mm
- ii) Plumb - 1 in 1000 of height
- iii) Levels - +/- 3 mm before any deflection has taken place

The above tolerance shall be 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. Any error, within the above tolerance limits 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.

i. 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.

- j. Generally, the "ordinary" class formwork 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. Plywood formwork 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 by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition. Ornamental formwork shall be used where ornamental and curved surfaces are required and shall be made of selected best quality well seasoned timber or plywood, which can be shaped correctly. The contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings.

10.23 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers / Conduits / Pipe and Other Misc.Embedded Fixtures

The contractor shall build into concrete work all the items as noted below; and shall embed them partly or fully as directed and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant IS and of approved manufacture to the satisfaction of the Engineer. Exposed surfaces of embedded materials shall be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surfaces 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 required items to be embedded shall be as follows:

- i) Inserts, hangers, anchors, frames around openings, manhole covers, Frames, floor clips, sleeves conduits and pipes.
- ii) Anchor bolts and plates for machinery, equipment and for structural steel work.
- iii) Dowel bars, etc. for concrete work
- iv) Lugs or plugs for door and window frames occurring in concrete work.
- v) Flashing and jointing in concrete work.
- vi) Any misc. embedments and fixture as may be required.
- vii) Convextra-GP2, SIKA grout or equivalent grouting material shall be used as per manufacturer's specification.

Correct location and alignment, as per drawings/instructions of all these embedded items shall be entirely the responsibility of the contractor.

10.24 Precast Concrete

The precast concrete shall be similar as for the cast-in-place concrete described herein. All precast work shall be carried out in a yard which shall be dry, properly levelled and having a hard and even surface. It shall be paved

with concrete or masonry as needed; and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Casing shall be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing and can be removed for erection after 28 days of curing. The moulds shall be of steel or of timber lined with G.I. sheet metal.

Lifting hooks as necessary 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. Precast concrete units, when ready, shall be transported to site by suitable means. 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.

10.25 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 stone chips 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. Finished grout shall be cured to ensure proper strength. 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, without any extra cost to the owner.

Alternatively non-shrink, free flow, cementitious grout like "Sikagrout 214 / Ankor NSG" / Masterflow 918 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.

10.26 Waterproofing of Concrete Structure

a) General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" or approved equivalent, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS: 2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

b) Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods:

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days:

Compressive strength	- 55 to 60 N / Sq. mm
Flexural Strength	- 25 to 30 N / Sq. mm
Tensile strength	- 15 N / Sq. mm (approx)
Bonding strength to concrete	- 3 N / Sq. mm (approx)
Bonding strength to steel	- 20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to owner.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

c) 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 as per manufacturer's specification to provide a waterproof concrete.

- i) 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 at no extra cost to the Owner to supervise the work, if desired by the Engineer.
- ii) 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 "No leek 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 Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

d) 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.

e) Protective Coating on Inside Surface

Two coats of cement based two-components polymer modified flexible protective and waterproofing slurry having 1 mm thickness for each coat shall be applied on the walls/ floor after proper surface preparation as per manufacturer's specification. The slurry shall be applied by brush.

f) Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known □pecialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls is required, these will be paid extra under suitable items in the contract. A 10 (ten) 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.

g) Polyethylene Films : Application in Walls or Base of Structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder:

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6
- ii) apply hot bitumen 80/100 grade (IS:73-1961) @ of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the

heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen
- v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.
- vii) Lay second layer of 100 gm. Brown craft paper laminated as (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 M10 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.

10.27 Protective coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using rubber / bitumen emulsion protective coating of approved manufacturer.

10.28 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.m 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.

10.29 Sampling and Testing

The contractor shall carry out all sampling and testing as per IS for the following items:

- a. Cement
Representative samples shall 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 as per IS:269. Soundness Tests shall also be carried out as

required. No cement from a particular consignment / batch shall be used on the works unless satisfactory 3 days and 7 days test results for compressive strength are known. These tests shall be of great importance as their results shall have bearing on the acceptance of concrete or otherwise.

b. Aggregates

The contractor shall carry out any or all the tests of aggregates as required as per IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be as per the relevant IS.

c. Water

Water for concrete works shall be tested as per IS: 3550 by the contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt shall be as per IS: 3025 & IS: 456.

d. Admixture

Air Entraining Agents (AEA): Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-à-vis quantity of A.E.A. used for all types of concrete shall be established by the contractor by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the contractor should check up, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results. Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the contractor.

e Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be as per IS:516 and IS:1199 with the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed apart from other tests as per IS:516. Sampling procedure, frequency of sampling and test specimen shall conform to clause 15 of IS: 456. To control the consistency of concrete from every mixing plant, slump tests and / or compacting factor tests in accordance with IS:1199 and as per clause 7.3.7(f) above shall be carried out by the contractor every 2 hours. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with clause 16 of IS:456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement shall be done as per specification by the contractor. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good by the contractor to the satisfaction of the Engineer.

f. Concrete for Equipment or Steel Structures Foundations

Concrete for equipment foundation, whether principal or auxiliary, shall be poured continuously so that the structure becomes monolithic, particular care being exercised to see that the base slabs, if any, are of

compact impervious construction. Tunnels, passages apertures and so forth shall be provided in accordance with the drawings for the installation of mechanical and electrical equipment, pipes or cables. The top elevation of the equipment foundations or parts shall be accurately cast to 20/50 mm (or more as may be specified on the drawings) above the level required for grouting and it shall be pneumatically chiseled of and well roughened just prior to the erection of the equipment concerned. All embedded anchor bolts or bolt sleeves shall be accurately and firmly set with the aid of approved templates, steel supports and / or other accessories. For holding the embedded bolts or sleeves in the correct position during concreting, template shall have to be of steel of suitable section approved by the Engineer in Charge. Two (2) sets of templates shall have to be provided, one to hold the bottom and the other the top of the bolts or sleeves. The bottom template shall be securely and rigidly fixed by providing anchorage arrangement and by welding to the lowest part of the steel reinforcement and other structural supports. The top templates shall be securely fixed by tying with guy wires and turn buckle arrangement to firm and rigid adjoining structures and stagings.

Bolt pockets, where required, shall be cast with wooden taper wedges. These shall be withdrawn at an appropriate time when the concrete has set, the pockets cleaned roughened and then covered or blocked thoroughly to prevent debris getting into these. The exposed portions of bolts and embedded parts shall be kept well greased and adequately protected from damage throughout construction. Any damages found shall have to be corrected at the contractor cost. The Purchaser shall have the right to use the foundations, pads, piers, slabs, floors and all concrete work as needed for other works or equipment erected prior to its "Taking over"

10.26 Special Conditions For Construction of TG Foundation

a) Scope

- i) The work to be performed under this contract consists of providing all materials except those supplied by the Purchaser, shuttering, staging, inserts, construction equipment, labour and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of the work, all in the strict accordance with the drawings, schedules and specifications and including revisions and amendments thereto and such detailed drawings as may be provided by the Consultant, during the execution of the work.
- ii) It is not the intent to specify completely herein all the details of designs and construction of the structure. However, the structure shall conform in all respects to high standards of Engineering, design and workmanship and be capable of performing in continuous commercial operation upto contractors guarantee in the manner acceptable to the Purchaser / Consultant who will interpret the meaning of drawings and specifications and shall have the power to reject any work or materials which in his judgment are not in full accordance therewith.

b) Form Work



- i) All forms shall be abundantly wetted on both sides before concrete is poured. The date of removing forms for each individual stage of construction shall be fixed by the Purchaser / Consultant.
- ii) The minimum period for striking of formwork shall be as follows:-
 - Vertical sides of beams and pedestals - 7 days
 - Bottom of beams / slabs - 28 days

However, the vertical faces shall be loosened after 24 hours of completion of concreting the supports.

- iii) Concrete surface shall not normally be patched or otherwise treated after the removal of forms. Where the surfaces exposed on stripping is not of a satisfactory nature, owing to the contractors failure to take necessary precaution before, during or after the concrete placing, such surfaces shall be worked and finished in accordance with the instructions of the Purchaser / Consultant at the cost of the contractor. The pores shall be filled in with a neat solution of cement and water applied by brush and when dry the surface shall be rubbed down with carborundum stone. The cost of the above treatment shall be deemed to be included in the unit rate entered by Contractor. The top surface of the T.G. deck shall be float-finished, unless otherwise specified to the required levels. There must be no surface grouting or treating which might draw the "fines" to the top. All shuttered surfaces shall be left as they strip without removing boards or panel markings.

Any serious honey combing will render the concrete work liable to rejection and cutting out and re-concreting wholly or partly as the Engineer in Charge directs. All costs involved in repairing defect shall be borne by the Contractor.

- iv) The arrangement and method for movement of workers during TG construction to various levels of the TG foundations shall be submitted well in the advance to the Engineer- in - Charge for his approval for taking up the work.
- v) In addition to the above paras the contractor shall also satisfy all other requirements for formwork mentioned in elsewhere in the specification.

c. Staging

- i) The entire staging for supporting the formwork, walkways and platforms for placing concreting equipments such as vibrators, etc., shall be of structural steel. The staging shall be designed for the worst combination of loading as specified hereinafter.
- ii) The Contractor shall submit 6 copies of design calculations and drawing to prove adequacy of the staging for approval of the consultant. On receipt of final approval, the contractor shall supply 20 copies of approved drawings for distribution.
- iii) The staging shall be so designed that no load from platforms are passed on to the formwork at the top.

- iv) All platforms, walkways etc. shall be clear of the formwork and at least 200 mm above it. The width of platforms and walkways shall be at least 1.2 metres for easy movement of labour both ways.
- v) The platforms shall be of planks or bamboo mats (clamped with steel strips suitably stiffened to avoid springing).
- vi) The form work and staging shall be designed for a live load of 1000 Kg/m².
- vii) Unit weight of green concrete shall be considered as 2500kg/m³ for design of form work and staging.
- viii) The staging shall be braced in both the directions.
- ix) The staging shall be supported on rigid surfaces at ground level.
- x) The staging shall be sufficiently rigid to prevent any distortion in the form work.

d. Special Precautions

- i) The contractor shall take all precautions to ensure concreting of TG Raft, columns and TG Deck in one pour each. Concreting shall be continuous and no break in concreting shall be permitted.
- ii) The Contractor shall prepare a scheme for concreting giving details of number of mixers, labour, vibrators, pouring schedule and obtain prior approval of the same from the Engineer-in-Charge before starting of concreting.
- iii) The Contractor shall ensure that at no time the temperature of the green concrete exceeds 38 degree C by taking proper precautions. If required, ice shall be added to control the temperature at no additional cost to the Purchaser.
- iv) Approved "Retarders" shall be used by the contractor in the proportions specified by the manufacturer for total concreting work of the TG foundation. The cost of the admixture shall be included in unit rates quoted by the Bidders.

e. Test for Soundness of Concrete

- i) After completion of the construction of TG foundations, the contractor shall get the Deck and column tested for soundness of concrete by "ultrasonic wave – non – destructive test method" from reputed research institutions as mentioned in Chapter-3.
- ii) If the test report calls for any rectification in the concrete works by way of pressure grouting or otherwise, the same shall be carried out by the contractor at no additional cost to the Purchaser to the satisfaction of the Purchaser / Consultant.

- iii) If require, any additional test to establish the adequacy of the rectification works carried out shall be done by the contractor at no extra cost to the Purchaser.

Quality Control Procedure.

The contractor shall establish & maintain quality control procedure for different items of works and material to ensure that all works are performed as per specification.

Contractor shall got approved field quality plan for all the works to be executed

Quality plan shall be prepared based on guide lines furnished in Volume-II of the specification.

11.0 DESCRIPTION OF BUILDINGS, STRUCTURES AND OTHER FACILITIES**11.1 TEMPORARY STRUCTURES FOR EXECUTION****11.1.1 Construction water:**

The Contractor will make his own arrangement (boring, pumping etc.) for withdrawing under ground water for construction purpose without any cost implication to the owner. Location of bore hole shall be got approved from the owner / consultant before execution.

11.1.2 Temporary site building

The CONTRACTOR shall provide for at his cost the following building facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory Rules regarding staff welfare facilities. All these building shall have brick cladding, Steel / AC sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/C as required.

11.1.3 Site office

Contractor shall provide about 500 sqm of office area with A/C and false ceiling for the use of Owner / Owner's representative in addition to the Contractor's requirement. Additionally an A/C Conference room to accommodate about 70 people shall also be provided in the site office complex for the Owner's use. In addition to these, basic facilities like toilet for gents and ladies, potable water tanks, soak pit and septic tank for sewage disposal shall also be provided. Covered parking area for parking 10 cars shall also be provided for Owner's use.

11.1.4 Stores

A covered store shall be provided with brick cladding and G.I./colour coated sheeting to store at least one month requirement of cement. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Covered storage area may also be provided to store other construction material which will be affected on exposure to wind, sun and rain.

Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.

Storage yard paved or unpaved shall be provided within the stores complex for storage of other material.

Proper fencing and security arrangement shall be provided for the stores complex.

Contractor may consider using the existing building in the site with necessary repairs and restoration for use of this facility, provided the same does not interfere with construction of Permanent works.

11.1.5 Temporary Workshop and Garage

The CONTRACTOR shall provide for a temporary workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities.

11.1.6 Fabrication yard

Depending on the extent of fabrication envisaged at site, the CONTRACTOR shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control. Portion of the yard shall have covered shed with H.O.T / E.O.T cranes so that fabrication work can proceed even during inclement weather.

11.1.7 Quality control laboratory

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER. All testing shall be carried out in presence of OWNER. Finally the laboratory shall be handed over to OWNER in good condition after completion of project.

11.1.8 Fuel storage area

CONTRACTOR shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility.

11.1.9 Staff Welfare facility

CONTRACTOR shall provide adequate facility for his staff inside the plant boundary such as Toilets for both gents and ladies, Canteens, drinking water facility, rest places, creches etc.

Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the CONTRACTOR's responsibility.

CONTRACTOR shall also provide for proper disposal of sewage and other wastewater to meet with the requirement of Pollution Board.

Construction and maintenance of the staff and labour colony to satisfy all statutory requirement is the sole responsibility of CONTRACTOR. Land required to construct staff & labour colony will be made available by the Owner to the Contractor within or close to plant boundary.

Contractor to establish a Fly Ash Brick Plant at site to fulfill the requirement of Fly Ash Bricks for the project.

11.2 TURBINE GENERATOR BUILDING

Turbine building (TG bay and heater bay) framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction.

Service and maintenance bays shall not have any intermediate floors, however a 1500 mm wide observation gallery with handrails shall be given along the wall at the operating floor level to observe the TG erection operation. Mezzanine floor, operating floor and deaerator floor shall be RCC floors over steel framing, where as the floors at any other levels may either be of RCC floors or may have chequered plate / gratings supported on structural steel frame work.

Crane capacity and crane rail level shall be fixed on the basis of the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level continuous walkways shall be provided on both sides of Turbine hall. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance requirement duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 150 mm thickness laid to a slope of 1 in 100 towards transformer yard, constructed over permanently colour coated galvanized MS troughed metal sheet of approved profile supported on steel purlins and trusses. TG bay roof shall be provided with exhaust system. *Access to roof shall be provided with structural steel staircase from Deaerator floor and the same stair shall have provision for access to crane maintenance walkways provided at crane girder level.*

Within the building, the concrete pedestal for supporting the turbine generators and Boiler Feed Pumps/motors will be completely isolated from the building floors for vibration control. The foundation for Turbogenerator and Boiler Feed Pumps/motors will be completely isolated from the building floors for vibration control. The concrete operating floor will be designed for construction and maintenance loadings of Turbogenerator. Hatchways with removable chequered plates or grating floor covers will provide access to equipment on lower floor and will be within turbine hall crane access.

Permanent colour coated sandwiched insulated metal cladding system from 3m (approx) above ground floor up to roof shall be provided on gable ends and A row. Brickwork shall generally be provided from ground floor to 3m (approx) height. On other rows brickwork shall be provided upto roof level. Wall in front of transformers shall be of adequate thickness to satisfy "fire rating" as per TAC regulations. On the heater bay side the brick wall shall be provided upto 1m above deaerator floor level. Cladding beyond the above level shall of permanent colour coated sandwiched insulated metal cladding system. Permanently colour coated single metal cladding sheet (non-insulated) shall be provided over brickwork above 3M (approx) from ground floor only when brickwork is technically required and provided as mentioned above. All internal walls shall be of brickwork.

Roof over heater bay shall consist of in-situ RCC slab of minimum 150 mm thickness laid to a slope of 1 in 100 towards boiler side, constructed over permanently colour coated galvanized MS troughed metal sheet of approved profile supported on steel beams.

All floors in Turbine Hall and Heater/Deaerator bay shall preferably be constructed over permanently colour coated galvanized MS troughed metal sheet of approved profile supported on steel beams otherwise removable type shuttering shall be used except chequered plate/grating floors.

Metal decking sheet for roof shall consist of permanently colour coated galvanized M.S. sheet and silicon modified polyester paint shall be used for permanent coating on exposed surface. The galvanization shall be 275gm/sqm and DFT of permanent colour coating shall be 20 micron (approx). Primer coat shall be provided on inner side. Minimum thickness of metal deck sheet shall be 0.8 mm. Profile and trough depth of metal deck sheet shall be decided by Contractor as per design requirement.

Elevator block shall be placed in the Heater bay. Necessary provisions shall be kept as per crane manufacturer's requirement.

Stairs and platforms shall be provided as required for maximum utility and safety. Stairs shall have to be provided as per TAC regulations and any other statutory requirements.

Supporting structure for power cycle piping shall be provided as necessary.

Minimum 1.0 m high RCC parapet shall be provided on each roof.

Windows shall be side-hung steel glazed using 6mm thick wired glass generally. However in areas where cladding is of sheeting fixed glazing in anodized aluminium framework and in accessible areas sliding windows in anodized aluminium framework using 6mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding cum / folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.

Staircase protected on all sides with fireproof enclosure shall be provided to satisfy TAC regulations. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying TAC regulations. Access cage ladders shall be given to TG building roof.

A 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 polymerized mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25 mm thick PCC (1:2:4) cast in panels of maximum 1.2x1.2m size and reinforced with 0.56mm dia galvanized chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22mm (min.) thick of approved colour and shade conforming to IS:13801 shall be provided for path way of 1m width for access of personnel and handling of equipment and for the entire area of the roof where equipment like A/C 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. MS rain water pipe of min. 150 mm OD conforming to

IS:1239 shall be provided to drain off the rainwater from roof. They shall be suitably concealed from the façade.

All the suspended floors in Main Plant Building are elsewhere in the BOP Area (having steel structure construction) should be supported on colour coated trough shaped permanent decking on beams.

All the intermediate floors shall be provided with proper drainage. Catch pit with CI grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same co-ordinate for all floor levels. 100 NB galvanized MS pipes conforming to IS:1239 shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided in ground floor to receive the water. Proper drainage arrangement shall be provided in the ground floor by means of RCC gravity channels with MS grills on top. The drainage shall be led to sumps from where the water shall be pumped to plant drainage, concrete kerb shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator should be provided as required to isolate oil from the drainage water where the water is mixed with oil.

In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.

Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.

Expansion joint shall be provided in the building, if required, to satisfy the requirements of IS:800 and IS:3414.

Suitable provision for future expansion shall be made by BIDDER while designing / executing the foundation system for last grid of main plant building.

In any case auxiliary columns shall not be supported on TG foundation. Preferably auxiliary columns shall be fabricated box section.

A minimum headroom of 2200 mm below beam bottom shall be given in the cable vaults. In control room false ceiling level shall be kept 3500 mm above floor level

Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards.

Cable vault in ground and second floor shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side

Switchgear room shall be provided with minimum two steel doors to satisfy statutory requirement. In addition a two leaf sliding doors of slush welded steel construction shall be provided to move the switchgears into the room making use of equipment lifting hatch provided in turbine building.

Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodized aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. All the doors shall be single leaf glazed aluminium doors for all cabins. For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. Control room wall upto the false ceiling level shall be of aluminium glazed partition on either side of air lock. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding all-round to reduce sound nuisance.

Battery room shall be provided with PVC doors in PVC framing. For Air washer room steel doors shall be used which shall be airtight. No window shall be provided in air washer room.

Control room and electronic cubicle room is to be provided with false ceiling. False ceiling shall be designed aesthetically properly arranging, supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling. Under deck insulation shall be provided for air washer room also.

Floor above control room where APRDS and other pipes are located as well as floor below the deaerator area shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room.

All openings in floor for switchgear and other panels shall be sealed with fireproof material after cables are connected.

11.3

MILL AND BUNKER BAY BUILDING

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coalbunkers, coal feeders and tripper arrangement to feed the coal into coal bunker.

The bunker shall be circular in plan and shall have the capacity as per the requirement of steam generator.

A mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This platform shall be of chequered plate or gratings over steel framing with handrail all around. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runway girders shall extend to the full length of mill bay to enable approach to the service bay also.

Framework for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper. Preferably each bunker shall be supported on minimum eight (8) numbers supports spaced equally.

Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.

Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel framework.

Tripper roof shall be of RCC supported on structural steel framework. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet shall be provided for the tripper roof. Access stair/ladder shall be provided from tripper floor to roof in each unit.

Metal deck sheet shall be used as a shuttering material for all RCC floors. Specification of metal deck sheet shall be same as 11.2 above.

In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air canons

Tripper floor and roof shall be given access through boiler staircase / elevators.

Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor upto 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanized trough sheet cladding shall be provided. Fixed steel windows with 6mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery

Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min. 50 thick screed over the water proofing treatment.

Rainwater down take pipes shall be of MS.

One number goods cum passenger elevator and two nos. of staircase shall provide access to all floor/platforms extending upto the roof level. Requisite nos. of corridor as per operational requirements shall be provided to access steam generator building from Mill building. The Mill building and steam generator building shall have expansion gap and corridor shall be connected with sliding supports.

Stainless steel liners shall be provided in bunkers for the conical / hyperbolic as well as vertical portion of Bunker. The grade of SS liner shall be SS316L.

Metal deck sheet used below RCC floors shall be treated as shuttering material only. Uniform thickness of slab, excluding corrugations shall be min. 150mm. In this case, top of steel of beam shall be decided carefully.

11.4 STEAM GENERATOR AREA PAVING

For paving in steam generator area, refer clause No. 6.12 of chapter 6 of this specification.

11.5 TRANSFORMER YARD

Generator transformer, station transformer, unit auxiliary transformer and service transformer are located in front of the turbine building. Transformers shall be installed on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through salt glazed pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as fire barrier wall.

RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer refer clause 17.6 also. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.

11.6 ESP Control Room

ESP panel control room buildings shall be RCC framed building with brick walls plastered on both faces, complete with drains, space conditioning, and building lighting. The building shall have a separate air-conditioned area; and a separate non air-conditioned area except as required for the contained equipment. The contractor shall ascertain the building size according to the design requirements.

11.7 SWITCHYARD STRUCTURES & CONTROL BUILDING

Extent of switchyard and number of towers and gantries and the size of switchyard control room will be as per the layout of the switchyard which has been outlined in Vol. IV of the specification. For rest of the detail, refer chapter 22 of this specification.

11.8 CIRCULATING WATER SYSTEM

The circulating water system envisaged for the plant is by using clarified water. RCC cooling water channel shall be of rectangular in shape and is to be designed as uncracked section for water face and cracked section with crack width of 0.1mm for earth face as water retaining structures as per IS:3370 Part-I to Part-IV. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel leading to the forebay of the CW pump house.

Expansion joints shall be given at spacing of about 30m. Pedestrian crossover shall be given across the channel at approx. 300m centers. The channel shall smoothly diverge and form the forebay in front of the pump house.

11.9 CW PUMP HOUSE & FOREBAY

The pump house and forebay structures shall be of RCC frame. Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump

house shall have RCC grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.

Pump sump, CW channel and forebay structure shall be designed as uncracked section for water face and cracked section with crack width limited to 0.1mm for earth face. Each sump shall be provided with stainless steel (SS 316L) groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. The stop log shall be epoxy painted and coarse / fine screens shall have stainless steel mesh over galvanized MS frame. Number of pump sump and stop log shall be as per the requirement of mechanical design. This floor shall have openings for lowering the lifting of stop logs and screens. These openings shall be covered with epoxy coated mild steel gratings when the screens are placed in position. Provision for handling of the screens and stoplogs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.

Vertical turbine pumps are envisaged in the Plant. Number of CW & ACW pumps shall be as per mechanical requirements and described in relevant sections of this specification.

An annex to the CW pump house shall be provided in RCC framed structure to accommodate switchgear and control room with cable vault below, chlorinator room and toilet block. Side cladding shall be of brickwork. All floor and roof shall be of RCC. Roof shall be given proper slope and heavy duty water proofing. Rain water down comers shall be of MS pipe conforming to IS:1239 with primer & paint of thickness 350 microns. Roofs shall be made accessible by MS cage ladder.

All doors shall be of flush welded steel construction. For switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of transformer yard shall be designed to satisfy fire rating as per TAC regulations.

An auxiliary transformer yard may be required in front of the switchgear room. Civil work similar to the transformer yard in front of MCC room shall be included in the scope of work.

In the pump house support blocks for butterfly valves and pipes along with proper handling facility shall be provided.

Foundation system for CW pump House shall be designed carefully keeping in view the nature of soil. For CW forebay structure (only) PRV can be used to relieve uplift water pressure on the base slab. In this case, base slab of the CW forebay shall be designed for 50% of water uplift pressure. CW forebay shall be open at top and galvanized MS handrails shall be provided all round the CW forebay.

Suitable thrust block to hold CW pipe line at various locations as per mechanical requirement is also in the scope of BIDDER.

11.10 CW Inlet and Outlet conduits



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Cooling water conduits of adequate size shall be provided from C.W pumps to condenser and hot water conduits from condenser to cooling tower. These conduits shall be formed of structural steel conforming to IS: 2062. The pipes shall be encased in R.C.C with a minimum thickness of 500 mm as external protection. However, the actual encasement thickness shall be based on stability against uplift with highest possible ground water level. Further it has to be designed for traffic load at road crossing. Outside RCC encasing, pipe shall be provided with 3 coats of epoxy paint of minimum DFT of 350 microns over two coats of compatible primer after sand blasting. Painting of overground piping (external surfaces) shall be as per relevant clause of Volume-III of this specification. The pipes shall be tested before commissioning of the system. Following design requirements shall be met:

- a) Provide a minimum clear distance of 1.0 m between ground level and the top of RC encasement.
- b) The design pressure shall be the highest of the following:
 - (i) Pump shut off head + Static head difference between normal water level at CW sump and the lowest invert elevation of the CW conduit.
 - (ii) Maximum pressure due to surges.
- c) The conduit shall also be designed for vacuum pressure inside and overburden pressure outside. The Vacuum pressure shall be based on the surge analysis but in no case less than 0.9 Kg/sq cm for the inlet and outlet pipes from the condenser and the delivery pipes from pump discharge up to the header and 0.5 kg /sq cm for the main inlet and discharge pipes. Suitable protection devices such as air release valves shall be provided to ensure that design vacuum pressures are not exceeded.
- d) The conduit shall be designed for surcharge of 2 t/m².
- e) The design shall be checked for other loading combinations of surcharge, transformer load, ground water pressure etc.,
- f) Manholes shall be provided at a maximum spacing of 150 m in straight reach of conduit. One manhole shall be provided at all horizontal bends and one at the lowest stretch between two vertical bends.
- g) Thrust block / anchor blocks shall be provided at bends.

11.11 CLARIFIED WATER CUM FIRE WATER PUMP HOUSE AND PUMPS/ TANK & EQUIPMENT FOUNDATIONS

Clarified/ Fire Water sump shall be water tight RCC construction with covered RCC roof. Vent pipes shall be provided at the roof. The pump house shall be single storeyed flat roofed RCC / steel framed building with brick / colour coated metal sheeting as side cladding. Monorail & gantry shall be provided for handling pumps.



The building shall be complete with doors, windows and rolling shutter. Capacity shall be as per Vol. III and Composite Water Scheme.

11.12 NON PLANT BUILDING

11.12.1 Service building

The service building shall be a reinforced concrete framed building. The building shall generally not exceed four storeys and shall be directly connected to the main plant building at operating floor. The floor area shall not be less than 1000 sqm for each floor. The building shall generally be air conditioned with false ceiling. Elevators as indicated in Vol III shall be provided. A grid of concrete beams and columns shall support the reinforced concrete roof (minimum 3% slope) and the floor slabs. The walls shall be of masonry construction, plastered internally and rendered externally. The service building shall have the following provisions:

- a. Seating accommodation for senior O&M executive along with supporting staff including furnitures of latest style. For the accommodation of all Executives permanent brick wall not to be provided, instead wooden partition wall of cubicle type is to be provided.
- b. Safety and Welfare Cell, First aid room
- c. Reception, drawing hall, library, print rooms and records room/archives.
- d. Conference hall with all amenities like latest style furnitures, loud speaker systems, LCD display equipments, service room etc.
- e. Mini conference hall with furnitures near UCB.
- f. Relay testing lab, electrical lab, C&I repair lab and transmitter lab.
- g. Pantry
- h. Toilets – Ladies & Gents in each floor as per specification.
- i. Telephone Exchange of 500 lines
- j. Electrical and LAN points at each seat in the cubicle, cabins & conference rooms with wiring and fittings.

The bidder has to furnish the three dimensional architectural plans along with the colour codes for the above buildings for approval of the Purchaser for adopting one among the alternatives proposed.

11.12.2 Storage Yard

A storage yard of 25,000sq-m shall be provided with a provision of 5000m.sq. covered area. The storage yard shall have compound wall of 3m height with anti-climbing devise. Covered area shall be of RC construction with RCC roof and brick wall for side cladding. Office space and toilets shall also be provided. Entry & exit of trucks shall be through rolling shutters of adequate size. In addition, a double-leaf steel flush door shall be provided for entry of the staff. Adequate windows shall be provided. The covered sheds shall be connected with bituminous roads in side storage yards. The storage yard shall be provided with 150mm thick gravel paving along with suitable drainage arrangement connected to plant drainage system. Location of storage yard will be decided during detail engineering as per availability of space at site.

11.12.3 Parking Sheds

Parking sheds (for both four wheelers and two wheelers) shall be provided at service building, security complex, at CW pump house area etc., at all locations for operating staff. The parking sheds shall be of RCC.

11.12.4 Workshop

The building shall house electrical, mechanical workshops and shall comprise the following facilities as a minimum requirement.

- a) Mechanical workshop – consisting of carpentry, Machine shop (for lathes, drilling machines, grinding machines etc.) ,Fabrication / welding and store.
- b) Electrical room
- c) Offices, rest room and toilet
- d) Heavy vehicle shed

The workshop building area shall be based on the equipment layout during detail engineering. The building must have provision of EOT crane for handling. The building shall be of RCC/ steel framed structures with brick masonry side cladding. For other detail and finishes refer to Architectural specification.

11.12.5 Fire Station

Fire station shall be single storey RCC framed building with brick walls in office area. Provision for parking of 2 fire tenders including 1 bay for maintenance with pit, office, duty room, stores, recreating room, record room and toilet blocks shall also be made. In addition adequate space shall be provided for hose drying and drill ground. The arrangement shall satisfy the requirement of local fire brigade. Minimum area for this facility shall be 150sq.m.

11.12.6 Canteen

A canteen building shall be provided for all personnel working in the power plant area. The Canteen Building will be able to cater for minimum 300 persons with staggered meal times in four group with an interval of 30 minutes. Seating arrangement of at least 100 persons shall be made. The following facilities shall be provided in the Canteen as a minimum requirement.

- a) Kitchen
- b) Pantry
- c) Stores
- d) Space for Plate and pot wash
- e) Area for freezer / refrigerators
- f) Staff rooms and toilets
- g) General gents and ladies toilets
- h) Administrator / caretaker room
- i) Dining Hall and service counter
- j) Parking area.

An Air-conditioned VIP Dining room shall be provided for 15 people. General Dining room shall be with Desert Coolers

The building shall be of RCC framed structure and flat roof with brick masonry as side cladding. Architectural details shall be as per specification.

11.13 MISCELLANEOUS PLANT BUILDING

11.13.1 Air Washer Room

This shall be a single/double storied steel framed building adjoining to the Turbo generator bay. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall receive cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided for. Doors shall be of flush welded steel and they shall be made airtight. Rolling shutter of adequate size should be provided for taking the equipment inside and truck with compressor. The roof framing shall support an underslung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Steel glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel door shall be provided for movement of personnel. Dimension of the building shall be decided by the CONTRACTOR to suit the dimension of the equipment he is supplying duly taking into account maintenance requirements.

11.13.2 Diesel Generator Cum Compressor House

This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided by the CONTRACTOR to suit equipment supplied. D.G set foundation shall be isolated from the floor.

All trenches shall be of RCC and shall be designed as water retaining structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

11.13.3 Pipe racks and cable racks

All cable and pipe routing in outlying area shall be clubbed and shall run over ground on structural steel 'pipe / cable' racks at a height not less than 3000 mm clear above grade level. Where the pipes cross roads / railway clear headroom shall be 8000 mm. The racks can be multi-tiered. Cable shall normally be laid above the pipes.

Pipe racks/cable racks shall be of structural steel frame and longitudinally braced and shall be designed for worst combination of loadings. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres.

Pipe racks for all connections from the existing station, existing pipe racks is to be used with necessary modification (or) new rack is to be erected.

Necessary access ladders and platforms to be provided for maintenance. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundation with bottom of base plate 300mm above adjoining ground level.

11.14 FUEL OIL HANDLING SYSTEM

Unloading pump houses to unload oil from road tankers or rail wagons shall be of single storey structural steel frame structure with GI sheet roofing and Brick walls. A paved platform shall be provided between the pump house and the rail wagon / road tanker parking area with plain cement concrete over rubble soling, sloped towards a peripheral drain. The drain will be led to a sump with oil water separator. No cable trenches will be permitted in the pump house.

Fuel oil pressurisation pump house will house fuel oil pumps, heaters and MCC's. This is also single storeyed structural steel framed structure with GI sheet roofing. The pumps will be located in an R.C.C basement. Protective hand rail shall be provided all round the basement. MCC shall be located at plinth level. Proper access shall be given to the basement. Basement shall be given proper drainage facility. The oil / water mixture collected in the sump will be led to an oil water separator. The basement shall be designed as a water retaining structure. Electric hoist crane or monorail facilities will have to be provided in all the pump houses as specified in the Mechanical section of the specification.

Fuel oil tanks shall be of structural steel designed as per IS:803.

Foundation of the fuel oil storage tank shall be provided with bitumen sand mixture laid over confined river sand bedding formed with RCC ring beam. The type of foundation to be adopted will depend on the soil condition. Where soil is very poor, tank may have to be founded on concrete pad resting on piles or the bearing capacity will be improved using ground improvement technique.

The storage tanks shall be surrounded by RCC wall to prevent the spread of fire or leakage of oil from a leaking tank to other areas. Minimum 750 mm wide walkway shall be provided on the dyke wall all-round. The height of the wall, c/c spacing of tanks as well as area provided within the concrete wall are to be decided based on the statutory requirements for the type of oil stored and the quantity of oil stored. The entire area outside the tank foundation and within the tank farm shall be paved with concrete. The paving shall slope towards RCC peripheral drains which shall lead to an oil water separator. RCC crossovers shall be provided at appropriate locations for entry of personal to the tank farm. Fuel oil storage area shall be protected by chain link fencing as in the case of Transformer yard. Extent of fencing shall be to satisfy statutory requirement. Foundations for trestles and pedestals for supporting the pipes, anchor blocks etc shall be provided in RCC at appropriate locations.

11.15 RAW WATER RESERVOIR

11.15.1 Arrangement of the Reservoir

The raw water reservoir shall be partially below ground and partially above ground. The Raw Water Reservoir shall have minimum live storage capacity as

per requirements mentioned in relevant section/volume of the specification for running excluding a margin of 300 mm for silting on bed.

On the basis of area available for development of the reservoir and the required capacity of raw water storage, the storage depth shall be worked out. Minimum free board of 500 mm shall be maintained from the top and the working storage capacity of the reservoir shall be worked out leaving 300 mm clearance for deposition of silt from the highest bottom level of the reservoir and free board of 500 mm from the reservoir top.

The reservoir shall be divided in two equal compartments by means of central divide wall. Arrangement to feed each compartment of the Reservoir separately with change-over facility with the provision of adequate gates/valves for water inlet of 100% capacity for each compartment shall be made with valve chamber. The inlet for the raw water reservoir should have arrangement for reducing the inlet velocity of water in order to avoid erosion of reservoir bottom or side walls in long run. Providing stilling chamber near inlet with weir for discharge of water to the reservoir separately for each compartment shall be preferred.

Proper arrangement for isolation of the compartments during maintenance and/or sludge removal of the reservoir shall be made. While one compartment is under maintenance and empty for repairing/cleaning of accumulated silt, the other compartment shall remain in operation.

The compartments shall be interconnected with adequate capacity/size of sluice valve with extended shaft spindle.

An overflow arrangement by means of M.S. pipes of adequate diameter and thickness or overflow spillway with other necessary arrangements shall be made separately for each compartment. The capacity of overflow arrangement shall be equal to the inflow in reservoir. The overflowing water shall be connected to the nearby storm water drain and/or plant water recovery schemes by suitable means.

The overflow arrangement shall be located near the pump house so that, if any overflow takes place, it will come to the notice of the operator working at the pump house.

One meter wide walk way and working platform of adequate area for operation of isolation valve with extended shaft spindle with hand railing of 1.00 Meter height on both the side of walkway shall be provided on the central divide wall. Similarly, to facilitate inspection, a concrete pathway of 2.00 Meter wide all around the reservoir shall also be provided at reservoir wall.

Pressure relief valves of adequate capacity and in sufficient number shall be provided at the bottom raft to release uplift pressure whenever there is a difference in water levels inside and outside of the reservoir. The pressure relief valve shall be provided and installed in position as per manufacturer's recommendations with graded filter materials below the bottom slab. The joint at the junction of HDPE lining and the valve throat shall be so finished that there is no leakage of water from the joint.

The design of the pressure relief valve shall be such that it should not allow the water to leak out from the reservoir in normal working condition even without any pressure and shall remain watertight.

The pressure relief valve shall start operating even with a pressure difference of 15 cm in water level outside and inside of the reservoir.

The pressure relief valves shall have necessary arrangement for water tightness with HDPE lining and for fixing in R.C.C. panels.

11.15.2 Peripheral walls:

The peripheral walls shall be of R.C.C. construction in M30 grade concrete satisfying all checks for loading and water tightness for water retaining structures. The base slab shall have rectangular cross section. The stem may be stepped or tapered with vertical face on water side. The walls shall be designed as un-cracked sections. If the height of the reservoir above finished ground level happens to be less than 1.00 Meter then the reservoir peripheral walls shall be provided with hand railing of 1.00 Meter height.

11.15.3 Bottom of Reservoir

The bottom of the reservoir shall be of cast in situ R.C.C. panels in concrete Grade M: 20 having minimum thickness of 200 mm & with 8 mm diameter HYSD reinforcement both ways in two layers laid on 75 mm thick PCC. Below the RCC bed HDPE lining work shall be provided. HDPE lining work shall comprise of 75 thick sand bedding below lining, 75 thick sand layer on top of lining and 25 thick cement mortar (1:4) layer provided on sand layer.

The bottom raft shall be laid in alternate panels of suitable dimensions with proper water tight construction joints. The panels in the bottom flooring shall be laid at adequate slope towards the de-silting chambers.

Suitable and adequate leak proof & water tight expansion and contraction joints shall also be provided at appropriate intervals for bottom raft of the reservoir as well as for side & central R.C.C. retaining walls. The junctions of raft/foundation for peripheral wall/central divide wall with the raft shall also be rendered watertight.

11.15.4 Central Divide Wall

The R.C.C. central divide wall shall be constructed in M-30 grade concrete. The R.C.C. divide wall shall satisfy all necessary checks for loading and water tightness for water retaining structures as well as sliding and overturning criteria. The central divide wall shall also be checked for sliding when one compartment is full and other is emptied for maintenance.

The bidder shall conduct all necessary soil explorations of the reservoir area for ascertaining the characteristics of soil strata and ground water table. While designing the reservoir walls, the ground water table shall be considered at developed ground level.

11.15.5 Drainage / De-silting of the reservoir

The drain/de-silting chambers for de-silting of the reservoir during the cleaning operation and with suitable inlet and outlet arrangement shall be provided in each compartment of the reservoir. The arrangement for draining the reservoir shall lead to nearby storm water drain/plant water recovery

schemes preferably by gravity with manually operated valves, drain chambers outside the reservoir and pipeline up to storm water drain.

In case, if gravity drainage arrangement is not possible, the arrangement shall be with portable de-sludging pumps. Necessary space provision/ pump platforms and power supply arrangement near the drain chambers shall be provided to facilitate operation of de-sludging pumps.

Two numbers adequate capacity of de-sludging pumps shall be supplied and provided by the Agency.

The base raft of the reservoir shall have slope towards the inlet of the reservoir and drain chamber shall be provided on that side.

11.15.6 Outlet from the Reservoir and inlet to the Pump House

The arrangement of outlet of water from the reservoir to the inlet of sump for the raw water pump house shall be provided in such a manner that all pumps in raw water pump house will be put to work even when either of the compartments is closed for maintenance.

Similarly, the fire water pumps installed in the pump house shall always have positive suction. The reservoir shall have arrangement to provide positive suction to the fire water pumps all the time even if either of the compartments is closed for maintenance.

11.15.7 Hydro-static Effect on Lining

The HDPE lining is intended to stop loss of water from reservoir into the ground. The ground water in the adjoining area may increase due to leakages from reservoir. In such an event, the reservoir shall be subjected to buoyant forces. Similarly, whenever the inside water level in the reservoir falls below the outside water table an uplift pressure will be exerted on the bottom raft.

In the system design, rate of filling the reservoir will match the rate of withdrawal with provision of occasional increased pumping at the intake to create storage. Ideally, the water level in the reservoir will gradually fall due to other losses which will be periodically made up by increased pumping at source.

11.15.8 Pressure Relief Valves

The uplift pressure is generated only when outside water level rises higher than water level inside the reservoir and/or the reservoir is at minimum water level. The Pressure release valves should start operating as soon as the differential head becomes 15 cm.

Considering the highest water level in the area and as per specifications under IS: 4558 and manufacturer's recommendations the size, spacing and pattern of providing the valves shall be decided.

The pressure relief valves shall be tested at the manufacturer's installation as well as at site.

11.15.9 H. D. P. E. Lining



The thickness of the HDPE lining is to be provided considering its durability and strength against forces during installation etc. General Specifications for the HDPE lining shall be as below:

1.	Minimum thickness	1 mm
2.	Density	0.954 gm/cc
3.	Yield strength	28 N/mm and
4.	Supply width of sheet	6-7 M.

Installation of H.D.P.E film shall be as per specification/Guidelines of approved applicator. Field test procedure and Manufacturer's test results shall be produced for verification of materials.

The contractor shall supply all the necessary information pertaining to the manufacturer of the H. D. P. E. Lining, material and characteristics of the lining

The lining material shall be got approved by the owner / consultant before placement of order to the supplier and shall be brought to site only after the inspection by the owner at factory.

The contractor shall submit FQP for laying of HDPE and placement of pressure relief valves.

11.16 RAW WATER PUMP HOUSE (INTAKE STRUCTURE) AND MAKE-UP WATER PUMP HOUSE :

11.16.1 A raw water pump house (intake structure) shall be constructed inside plant boundary near the Lower Ganga Canal to pump the Raw water through MS pipes to Raw Water reservoir. Desilting chamber adjacent to raw water pump house to remove the silt from incoming water from Lower Ganga Canal shall be provided. Size of desilting chamber and raw water pump house will be as per mechanical requirement. The Raw Water Pump House shall be made of RCC construction with RCC roof slab and brick cladding around. MCC and switchgear room and transformer foundations for this system shall be provided at suitable location as per requirement and approved layout. The substructure of pump house shall be designed as uncracked section with ground water table at finished grade level.

11.16.2 A plant water makeup pump house shall be constructed near raw water reservoir to pump the make up water through MS pipes to clarifiers located in the PT plant. Size, layout and details shall be as per functional and system design requirements described in relevant sections/volumes of this specification. This pump house shall be placed adjacent to raw water reservoir. The Plant Water Make-up Pump House shall be made of RCC construction with RCC roof slab and brick cladding around. MCC and switchgear room and transformer foundations for this system shall be provided at suitable location as per requirement and approved layout. The substructure of pump house shall be designed as uncracked section with ground water table at finished grade level.

11.17 OTHER PLANT AND NON-PLANT BUILDINGS :



All other plant and non-plant buildings except those already mentioned in this Chapter shall be made of RCC construction with RCC roof slab and brick cladding around. Type of foundation (open/pile) shall be as per approved geotechnical investigation report. Cable trenches, equipment foundations, pipe trenches, drains, pits, duct-banks, transformer foundations, fire walls etc. shall be provided as per requirements.

11.18 CONDENSATE STORAGE TANK FOUNDATION :

Foundation of the condensate storage tank shall be provided with bitumen sand mixture laid over confined river sand bedding formed with RCC ring beam. The type of foundation to be adopted will depend on the soil condition. Where soil is very poor, tank may have to be founded on concrete pad resting on piles or the bearing capacity will be improved using ground improvement technique.

12.0 REINFORCED CONCRETE CHIMNEY

12.1 Scope

This specification covers the general requirements for design and construction of reinforced concrete single flue chimney of circular cross section including RCC shell, steel flue, internal platforms, staircase, appurtenances, fixtures, fittings, conduit and other embedment, lift (inside windshield), natural ventilation etc. complete.

12.2 Codes and Standards

a)	IS:456-2000	:	Code of practice and reinforced concrete
b)	IS:4998	:	Criteria for design of reinforced concrete chimneys – Part 1 Design Criteria -1975
c)	IS:4998	:	Criteria for design of reinforced concrete Part 1 Assessment of loads - 1992
d)	IS:875 (All Parts)	:	Code of Practice for Design loads for buildings & Structures
e)	IS:1893-2002: (Part-1) Fifth revision	:	Criteria for earthquake resistant design of structures
f)	IS:1893-2002: (Part-4)	:	Criteria for earthquake resistant design of structures: Part 4- Industrial structures including Stack like structures
g)	IS:432 (Part 1):	:	Mild steel and tensile medium steel bars
h)	IS:1786	:	Cold twisted steel bars for concrete reinforcement
i)	IS:800	:	Code of Practice for general building construction steel.
j)	IS:158	:	Ready mixed paint, brushing, bituminous, black. lead free, acid, alkali, water and heat resisting for general purposes.
k)	IS:1239	:	Mild steel tubes, tubulars and other wrought steel fittings, Part-1 – Mild steel tubes
l)	IS:1904	:	Code of practice for design and construction of foundations in soils : General requirements
m)	IS:2062	:	Hot Rolled low, medium & high tensile structural steel.
n)	IS:3043	:	Code of practice for earthing

- o) IS:3346 : Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)
- p) IS:3677 : Un-bonded rock and slag wool for thermal insulation.
- q) IS:8183 : Bonded mineral wool.
- r) ASCE-1975 : Design and construction of steel chimney liners. Task committee on steel chimney liners, Fossil Power Committee, Power Division, ASCE.
- s) IS: 6533 : Design construction of steel chimney- code of Practice (Part1 &2)
- t) Vickery, B.J "Wind Induced Loads on Reinforced Concrete Chimneys" Paper presented at National Seminar on Tall Reinforced Concrete Chimneys, 25-27 April, 1985, New Delhi.
- u) Vickery, B.J. and Basu, "The response of reinforced concrete chimneys to vortex shedding", R I Journal of Engineering Structures, 1984, Volume-6.
- v) Manohar, S.N. "Tall Chimneys – Design and Construction", Tata McGraw Hill Publishing Company limited, New Delhi.
- w) Pinfold, G.M, "Reinforced Concrete Chimneys and Towers", View Point Publication, cement and concrete association, U.K.
- x) The requirements of department of Civil Aviation, Government of India.
- y) Reference may also be made to ACI:307-1979 " Specification for design and construction of RC Chimney", if some items are not covered in India Codes.

12.3 Loading & their Combinations

12.3.1 Dead Load

All permanent loads due to the weight of chimney shell, internal platforms and lining supported on them, ladders, flue ducts, staircases, other accessories etc.

12.3.2 Imposed Load

- i) Imposed load on service platform around Chimney shall, shall be taken as 500 Kg/m². Design live load during construction / erection shall be considered as 1000 Kg/m².
- ii) Imposed loads from duct joining the Chimney shall be considered.

12.3.3 Local Loads

Effect of local loads such as moment produced by corbels, platforms, overhanging, oscillation and thermal gradient in addition to other if any shall also be considered. The group efficiency factor for the pile in foundation of chimney shall not be less than 3.

12.3.4 Thermal Effect

Due to the effect of temperature gradient ΔT , vertical and circumferential stresses are developed. These stresses induced in the concrete shall not exceed values given in IS:4998.

Flue gas temperature at inlet / exit 127°C (approx.)

The temperature gradient ΔT across the shell thickness of windshield shall be calculated as per IS: 4998 (Part-I) – 1975 but subject to a minimum of 20°C . Temperature stresses will be calculated according to the procedures given in ACI-307 and IS: 4998.

12.3.5 Seismic / Earthquake Load

Earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893-2005 using the Response Spectrum Method. Damping factor to be adopted shall not be more than 3% for reinforced cement stacks. The analysis shall be furnished for a combination of five modes.

12.3.6 Wind Load

Wind load calculation will be done as per IS:4998 (Part-1) and IS:875 (Part-3) Dynamic analysis will be carried out and stability ensured under such condition.

12.3.7 Along Wind Static Analysis.

Wind parameters to be considered for calculating design wind speed and pressure shall be as follows.

Basic wind speed = 47 m/s (upto 10m above normal ground level) as per IS:875 (Part-3) : 1987.

$$\begin{aligned} K_1 &= 1.07 \\ K_2 &= \text{(Table 2 \& Table 33, Category = 1, Class-C)} \\ K_3 &= 1.0 \end{aligned}$$

Aerodynamic Interference Effect (proximity effect) due to presence of other tall structures and stacks in the vicinity shall be assessed based on wind tunnel test to be carried by specialized agency in this field acceptable to Owner and shall be incorporated in design.

A provision of 10% increase in the wind load forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs. However, for final designs, the increase can be as per the recommendations of the agency carrying out wind tunnel studies.

The "gust factor" will be calculated according to the method given in IS:4998 (Part-I) – 1992. Dynamic modulus of Elasticity of concrete as recommended in IS:4998 (Part-1) – 1992 will be used for calculating the natural frequencies of the chimney.

C_d will be taken as 0.8 for the concrete shell in general.

Along wind response of chimney shall be calculated both by gust factor method in A-5.1 and simplified method in A-4.1 of IS:4998 Part-1, 1992. For design, higher of the along wind loads shall be used.

12.3.8 Across Wind

The across wind response of the Chimney will be evaluated as per IS:4998 (Part-1)/ACI307-98. Chimney shall be designed without considering provision of strakes.

Method given in Section A-4 as well as A-5 of IS: 4998 (Part-I) – 1992 shall be followed. Peak Oscillatory Lift Coefficient C_L shall be taken as 0.16 and Strouhal Number S_n as 0.2. Most critical moment shall be considered for design of the Chimney.

12.3.9 Ring Moments Due to Wind

The circumferential ring moment due to wind will be calculated in accordance with clause 5.4 of IS:4998 (Part-I) – 1992. The wind induced stresses in concrete and steel shall be calculated in accordance with Cl. No. D-2.2.7, D-2.2.8 and D-2.2.9 of IS:4998 (Part-I) – 1975.

12.3.10 Component Design Criteria

Design of R.C. Chimney will be done in accordance with the requirement of IS-4998. The geometry of the chimney will be fixed as per the flue arrangement and the requirements of exit velocity. Exit velocity of flue shall be 25 m/sec (approx).

The heat insulation of the liners and pressurized ventilation system shall be so designed that temperature in annular space between the chimney shell and flues does not exceed 45 Deg.C in peak summers.

The Contractor shall carry out, at his own cost, model test of chimney in wind tunnel in an approved laboratory to investigate the aerodynamic behavior of the chimney.

The concrete shell shall be designed as per working stress method as per following load combinations. The modular ratio shall be calculated as per annexure-3 of IS:456.

- a) Dead load.
- b) Dead load + Wind Load
- c) Dead load + Earthquake forces.
- d) Dead load + Temperature effect.
- e) Dead load + Wind load + Temperature effect.
- f) Dead load + Earthquake force + Temperature effect.
- g) Circumferential stresses due to temperature effect.

- h) Circumferential tensile stresses due to wind inducing ring moment.
- i) Circumferential compressive stress due to wind induced ring moment combined with temperature.

In Load combinations (a) to (i) above, dead load considered shall be with or without the weight of steel lining for flues & platforms, whichever condition is more critical.

1. Across wind loads shall be combined with co-existing along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-existing along wind loads.
2. The profile and thickness of RCC shell shall be provided as required by stress calculations. However, the thickness of the shell has also to be determined on the basis of wind tunnel model studies and any increase, in the thickness of shell or quantities required to be made as per report shall be followed without any extra cost. Minimum thickness of the shell at top shall be 500mm & at junction of shell & pile cap shall be 950mm. However, uniform thickness of shell shall be maintained from top of raft to 3.0 m above top of flue duct entry.
3. Stresses in the shell shall be checked at 10metre intervals along the height of the shell or at every corbel location or whichever distance is less. These stresses shall be within permissible limits.
4. The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than $H/500$ where H is the total height of the windshield above top of the pile cap.
5. The dynamic modulus or elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS:4998 (Part-I) – 1992.
6. The static modulus of elasticity of concrete shall be taken as under.

5000√ fck for instantaneous loadings. Where fck is the characteristic compressive strength of concrete as per clause 6.2.3 of IS: 456-2000.
7. At any section of the shell vertical bars shall be uniformly spaced. Non uniform spacing of vertical bars is not acceptable.
8. Reinforcement in the shell shall be provided as per IS:4998 (Part-I) – 1975. Minimum vertical reinforcement in the shell shall be 0.3% of concrete area. The maximum spacing of vertical reinforcement bars shall not be more than 250mm on each face. The minimum circumferential reinforcement shall be 0.2% of concrete area. The maximum spacing of horizontal reinforcement bars shall not be more than 200mm on each face. The circumferential reinforcement for a height from the top equal to half the shell outer diameter or 3 meters whichever is more shall be twice that required from design forces. The clear cover to reinforcement shall be 50mm. Circumferential reinforcement shall be placed around the exterior of and securely wired or welded to the vertical bars at an interval of not more than 600mm.

The diameter of reinforcing bar for 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.

One third of the vertical bars can only be lapped at one section.

9. Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. The maximum width of opening shall be limited to an angle of not more than 30° subtended at the centre of the concrete shell. Adequately designed openings for ventilation shall be provided along periphery of the wind shield at specified levels as per requirements.

The total plan area of the openings at a particular section shall not be more than 15% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening. The extra reinforcement around opening shall satisfy the requirements given in the following documents and the highest shall be provided.

- a) IS:4998 (Part-I)
 - b) ACI 307.
 - c) Reinforced concrete chimney and tower by M.G. Pinfield. The value of K_1 shall be taken as 0.11 as per data on page No. 186.
 - d) Minimum half number of extra horizontal bars in shell around the openings to continue for complete circle round for both faces and both sides.
10. Embedments, if required, to support the stair-case shall be provided in the shell.
11. Expansion anchors shall be used to attach conduit, lightning and protection equipments, lighting fixtures and other lightweight appurtenances.
12. Uniform Grade of concrete shall be adopted throughout the height of chimney shell.
13. Ground floor slab and drainage :

150 mm thick slab-on-grade over 100mm thick PCC (M-10) laid over 250mm thick (compacted) boulder soling with interstices filled with moorum and sand shall be provided at ground floor. Proper slope towards internal periphery shall be provided in ground floor. RCC drain shall be provided around internal periphery of shell which shall be connected to drainage outside.

18. Temporary Lightning Protection :

During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two (2) permanent electrical earthing conductors. After top lift of the chimney shell has been completed, temporary air terminations, which may consist of reinforcing bars, should be installed at the top to serve as temporary protection until

the lining and cap are completed and permanent air terminations, conductors etc. are complete

19. Temperature of concrete for pile cap shall not exceed 23° C at the time of pouring.

12.3.11 Permissible Stresses for Chimney Shell

The stress in concrete and steel reinforcement shall not exceed the limits given CL-7.0 of IS:4998(Part-1)-1975 for various load combinations, excepting the stress in concrete for the case of dead load + wind load which shall not exceed $0.28F_{ck}$ where F_{ck} is the Characteristic compressive strength of concrete. The stress in concrete at the junction of shell and foundation will be limited to $0.28F_{ck}$ where F_{ck} is the characteristic compressive strength of the weaker concrete between shell and foundation.

12.4 Grades of concrete and steel

Concrete grade to be used for foundation and shell shall be M30 (minimum). Cement content in concrete shall not be less than 400kg/m^3 .

Cement to be used for pile cap and above grade level shall be 43 grade ordinary portland cement. Only one grade of cement shall be used throughout the structure.

HYSD bars of grade Fe 500 bars conforming to IS 1786 shall be used as reinforcement.

12.5 Steel Liner (Flue)

12.5.1 General

Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting structure.

The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. The liner shall be supported atleast at five different levels, and restrained laterally at several levels, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between.

The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion compensator.

Clean-out door shall be provided below the flue for removal of ash.

12.5.2 Design of Steel Liners

Steel liners shall, in general, be designed meeting the requirements of the document, "Design and construction of steel chimney liners", prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.

The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20 to 25 meters/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 meters/second) to enable adequate dispersion of the flue gases. For this purpose, 100% turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60% turbine MCR condition with design coal / worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition.

The supporting / restraining arrangement of the liners at intermediate platform should be such that expansion of the liners longitudinally or circumferentially is not restrained.

12.6 Insulation

(a) On exterior surface of flue.

The flue shall be insulated externally. 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 100 kg/cum for resin bonded rock wool. The coefficient thermal conductivity of insulation shall be $0.52 \text{ mW} / \text{cm}^{\circ} \text{C}$ at a mean temperature of 100°C . Insulation / wrapping over flue can shall be done at ground level before erection.

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 60°C . The draught of air in the annular space shall be the natural draught 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 annular air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. However, a minimum of 50 mm thick (2 layers of 25 mm) insulation shall be provided on the external face of flue.

The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450mm c/c both horizontally and vertically. The studs shall be galvanized plated and be of a minimum thickness of 10 gauge and 75 mm wide. The studs shall extend a minimum of 25 mm beyond the thickness of insulation. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanized wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a

minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centers. Any form of lacing the mesh fibres together will not be permitted.

Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. This shall be protected from the elements by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel.

Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings by the contractor shall be carried out.

Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall noise Reduction Coefficient shall be 0.80 or better.

(b) Load Bearing and Side Restraints of Flues

Load bearing insulation assembly to have (i) a properly machined mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead / elastomeric sheet at top, and (iii) top late formed of two numbers insulation blocks each made of minimum 50 mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) or equivalent bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 or equivalent and stainless steel plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and mild steel to IS:2062. SINDANYO BLOCKS or equivalent shall be suitable for operation at 320°C and shall primarily satisfy the following physical properties:

- i) Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.
- ii) Minimum shear strength of 30 N/sq.mm when tested in accordance with BS:3497-1979.
- iii) Thermal conductivity shall not exceed 0.67 W/m Deg.C at a mean temperature of 200°C and its coeff. of linear expansion not to exceed 1.2×10^{-5} per Deg.C.
- iv) Adhesive used for bonding purposes shall be of material with equivalent high temperature properties as approved Foundation Engineer. It may be of "Fortafix Fiborclad Adhesive" as manufactured by Fortafix Ltd., England or equivalent.

12.7

Liner Hood:



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



The liner hood provided at top of flue shall be fabricated from 6mm thick (minimum) stainless steel sheets of grade 316L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding. All sections of the hood shall be anchored in places with stainless steel bolts / nuts. Slot holes shall be provided to make allowances for differential expansions / movements.

12.8 Internal Platforms

Minimum 5 number of Internal platforms shall be provided, unless indicated otherwise elsewhere.

The platform shall be designed for dead, imposed (live), erection work and other possible loadings and temperature effects. These platforms shall provide support and lateral restraint to the steel liners and provide access for inspections & maintenance. Forces imposed on the floor due to lateral restraint of flues shall be enhanced for impact effects. These platforms shall also be designed suitably for liner erection works.

The platform shall be supported on a grid work of structural steel beams supported from the wind shield. Top most grid work shall support RCC roof slab, where as other grid work shall support M.S. gratings as required from functional requirement. Corrosion allowance of 2 mm (minimum) shall be kept in the design of girders. Live load for the design of platform shall be 5 kN/sqm.

The members of the beam grid shall be assembled by high precision bolted connections only. The member dimensions shall be made to suit the as built dimension within the wind shield. Painting of the beams shall be as per Cl. 12.13 of this Chapter after surface preparation as per IS:1477.

The support of the beams on the R.C.C. shell shall be so designed that only vertical load is transferred to the wind shield without any temperature effect and local torsional / local bending moment.

After fabricating, the members of the individual platforms shall be pre-assembled at ground level and checked for trueness with respect to dimensions and orientation.

The gratings shall be fabricated from M.S. flats comprising of 40x5 thick bracing bars spaced at 40 c/c and 25x4 thick space bar. The grating shall be hot dip galvanized.

Handrails shall be provided with kick plates 65x8 mm along the platform edges. Openings for the elevator shall also be surrounded by a handrail as above. The same arrangements shall be provided at all stair case landing/ladder access points, stopper plates shall be provided to prevent gates from swinging outwards. 32mm galvanized steel pipe posts at not more than 1500mm spacing shall be provided for handrail. Height of hand railing shall not be less than 1250mm. There shall be minimum of three handrails at 450mm, 850mm, & 1250mm above platform level. 32mm dia G.I. drainage spouts, if required, shall be provided in the platform for drainage of water.

Maximum deflection of main plate girders supporting flues and gratings shall be restricted to L/600, however maximum deflection for secondary beams supported on main girder shall be L/325.

12.9 External Platform

External platform shall be provided as per directorate of air routes and aerodromes (DARA) circular for locating aviation warning lights. The platforms shall be equally spaced at a spacing of 40m (maximum)

The minimum clear width of platform shall be 1200mm and a minimum live load of 500 kg per m² shall be considered for design in addition to dead loads and incidental loads.

Hand railing shall be provided all around external platforms including hood platforms using 32 NP GI pipes. The spacing of railing of posts shall not be more than 1500mm center to centre. Height shall be 1250mm. There shall be 3 hand rails at about 450mm, 850mm & 1250mm respectively above platform level. The posts shall be embedded in RCC curb (150 x 200 high) at outside face of platforms.

32mm GI drainage spouts shall be provided in platforms for drainage of rain water.

12.10 Design of Transition Ducting

The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and provision of restraint / support arrangement as required.

The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary auxiliary ducting as well as soot collecting hoppers located below flue can. Soot hoppers shall be lined with SS grade AISI 304. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.

The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimize flue gas pressure losses.

The plate thickness of the ducts shall be arrived at from minimum (i.e. code) requirements, structural considerations and corrosion allowances. Material of construction shall be COR-TEN steel conforming to IS:2062. Minimum thickness shall be 10 mm.

The duct work shall be insulated with 75 mm thick insulation (3 layers of 25 thick sheets) as per requirements of clause 18.11 and protected with aluminium foil of minimum 1mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning.

The duct work and its supporting structures shall be designed for the most severe of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, wind loading, flue gas pressure loading and thermal loading.

12.11 Expansion Compensator

The suspended portion of the liner shall be connected to the bottom supported portion of the liner by an expansion joint. The joint shall be able to compensate for the large thermal movements of the steel flue, gas tight, acid resistant, heat resistant and provide an adequate insulating medium to avoid excessive overheating in the access void.

The materials used for the fabrication of the expansion joints shall be suitable for the flue gas conditions specified herein, and shall not deteriorate during transit, site handling, storage and installation.

The expansion joint shall be manufactured by a specialist for similar type of joints. The BIDDER shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the EMPLOYER's review. On award of contract, full details of materials to be supplied along with fabrication drawings shall be supplied by the CONTRACTOR for the EMPLOYER'S approval. The CONTRACTOR shall procure the units only after obtaining the EMPLOYER'S approval.

The expansion joints shall be made of flexible fibre. They should be air tight and impermeable and should withstand the maximum serviceable temperatures of the flue gas.

The CONTRACTOR shall furnish in complete an installation, dismantling and maintenance user handbook. A draft of the handbook shall be submitted to the EMPLOYER for his approval well before the installation commences.

The CONTRACTOR shall also supply spare expansion joints complete with instructions for storage, fitting, instructions, spare accessories, tools for installation, etc., to replace faulty / used expansion joints at a later date. The spares should withstand a storage period of not less than 10 years.

The fabric for expansion compensator shall comprise several layers of materials given below in order from the gas side:

- a) Two layers of insulation, each consisting of heavy weight glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 kg/sqm.
- b) A continuous filament glass cloth coated both sides with a fluoro-elastomer having an approximate weight of 1.5 kg/sq.m.
- c) Two layers of PTFE (Poly Tetra Flouro-Ethylene) film of minimum thickness 0.15 mm each.
- d) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 kg/sq.m.

12.12 Liner Test Ports

Gas sampling ports fabricated from stainless steel with flanged ends shall be provided for liner at platform levels where indicated including proper insulation, blank plates, nuts, bolts, etc. The location, orientation and level of ports shall be as per Central Pollution Control Board regulations. Two opacity measurement ports fabricated from stainless steel pipe shall also be provided in each liner at the same platform level of the gas sampling ports.

Bidder shall provide for the purposes of instrumentation other than the sampling ports mentioned above required number of 38 NB conduits including pull wires, junction boxes and pull boxes, all securely tacked / anchored to internal of shell and S 316 L plates below each pipe insert for fixing of measuring instruments.

12.13 Staircase

A structural steel staircase shall be provided inside the wind shield, connecting the grade slab to the topmost platform below the roof slab. The staircase shall be supported by a structural steel framework supported from platform to platform independently of the wind shield. Connection of the structural support to the platform beam shall be so chosen as to permit unrestrained deflection of the platform supporting beam. Clear width of the stair treads inside stringers shall be 750 mm. Tread shall be of 25 mm thick M.S. gratings hot dip galvanized with anti-skid nosing. Tread shall be minimum 250 mm wide. Maximum riser shall be 175 mm. Handrail shall be of M.S. pipe type medium of 32 mm NB as per IS:1161 with toe protection of 65x8 mm flats, the complete handrail being hot dip galvanized. 32mm galvanized steel pipes posts at not more than 2000 mm spacing shall be provided for handrail. Height of hand railing shall not be less than 1250 mm. There shall be minimum of three handrails at 450 mm, 850 mm & 1250 mm above platform level. All structural steel work other than stair treads shall be provided with 2 coats of zinc chromate red oxide primer followed by 3 coats of synthetic enamel painting of approved brand and shade. All field connection shall be by bolting only. The arrangement of staircase shall ensure easy accessibility to elevators. Staircase and its connection shall be designed for a live load of 5 kN/sqm.

12.14 Ladder

Steel cage ladder hot dip galvanized shall be provided from the last platform to the roof slab. Stringers shall be of flat 75x10 with a clear distance of 400 mm in between; rungs shall be of 20 mm diameter mild steel rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable stays connected to the platform supporting framework. The ladder and its connection shall be designed for a load of 175 kg at any location.

12.15 Lift

Lift shall be provided for the chimney inside the wind shield. The lift shall be of open cage type and suitable for corrosive and dusty atmosphere that generally exists in thermal power stations/industrial complexes. It shall generally conform to the provisions of IS:1860 and IS:4289 unless otherwise specified.

The lift shall have a minimum carrying capacity of 400 kg at a speed of 0.70 metre per second. The lift shall be of rack and pinion driven service type of approved make.

All the control devices inside the car shall be housed in a dust free and water proof enclosure. Only copper conductor FRLS insulated armoured cable of suitable size shall be included in BIDDER's scope.

Landing at all locations of platforms shall be provided unless otherwise specified elsewhere.



Construction of guard cage and supply of other accessories required for satisfactory and safe operation of lift shall be included in BIDDER's scope. BIDDER shall also supply and install safety devices such as automatic stop equipment, over speed governor etc. all complete as per Manufacturer's recommendation.

All the embedments for the lift structure, approach platforms at landing levels and the lift supporting structure including lift car shall be hot dip galvanized.

12.16 Enclosure Walls

Reinforced concrete walls shall be provided at grade level around staircase & elevator to make the enclosed space air tight and free from ash & dust for the comfort & safety of personal, who are required to go into the chimney for maintenance and inspection purpose. Height of enclosure wall shall be 10m (minimum) or as per the requirement of client. All materials for the design of walls shall be as per relevant IS codes.

12.17 Doors

(a) Clean Outdoors

Steel flue shall be provided with clean outdoor having clear dimension of 650 mm x 825 mm at appropriate location with proper access for operating the door. The edges of the doors shall be of hollow steel construction with inner plate of 8 mm and outer plate of 6 mm with suitable infill of stiffeners. The hollow space shall be filled up with insulation of the type used around flues. In addition around the door openings, removable type of insulation similar to the insulation provided around flue shall be provided. The door shall be of hinged type and provided with locking device in addition to Swivel studs with wing nuts on the remaining 3 edges. The door shall be openable both from inside and outside.

(b) Removable Cladding / Access Door

A rolling shutter of side 4m x 5m shall be provided near the base of the wind shield at ground level for the purposes of flue can erection and ash removal from hoppers. Bottom of rolling shutter shall be at 300 mm from paved level. This rolling shutter shall be provided with a minimum two coats of acid and alkali resistant paint conforming to IS:158 type I to give a DFT of 75 microns. The outside surface shall be provided with 2 coats of zinc red oxide primer and two coats of synthetic enamel paint.

12.18 Chimney Roof & Roof Drainage

The chimney roof shall be of RCC slab suitably supported on MS beams. The roof shall be sloped towards rain water down take catch pits covered with CI gratings. The roof shall be designed to cater for differential movement between the shell and the liners including circumferential expansion and contraction due to temperature variation. 1200 mm high RCC parapet formed by windshield shall be provided at roof level.

The roof shall be provided with a hatch for access from the flue support platform. The hatch shall have a single leaf door with a minimum thickness of 6 mm to cover a clear opening of 750 mm x 1000 mm. The hatch shall include the door, metal curb, draft seal, spring latch, hold-open device and all hardware. All joints shall be welded and ground smooth. The curb shall be 300 mm in height with a suitable lip which shall include a continuous neoprene seal strip to make the hatch air-tight when the cover is closed. The hatch shall be openable from both inside and outside and shall be provided with automatic hold open arm, easy one hand release and spring latch. All the items of the door shall be of stainless steel of grade 316 L and then painted with heavy duty acid and heat resistant paint as per requirement of IS:158.

The roof slab and the inside surfaces of the wind shield shall be lined with 20 mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base.

Roof slab structure shall be designed to serve as a lifting platform for supporting the weight of flues during erection.

The tiles shall be pointed using a phenolic based resin cement mortar conforming to IS:4832 (Part-2).

The bedding mortar and phenolic based resin mortar should be acid-proof, chemical resistant and water-proof. They shall in particular be resistant to sulphuric acid and hydrochloric acid.

CI/UPVC rain water pipes shall be provided within the interior of the shell to remove rain water collected on the roof. Rain water inlet into the pipes at roof level shall be provided with CI grating. The rain water down take pipe shall be led to a manhole chamber inside wind shield suitably lined with acid / alkali resistant brick lining. From the manhole the drainage water shall be led out of the chimney wind shield through CI pipe to a manhole chamber outside wind shield and from there to Effluent Treatment Plant.

12.19 Acid Drains and Manholes

In the event of flue gas condensation within the flues acids may be drained out at the base with the provision of stainless steel pipes connected to the soot hopper outlets in each flue located outside the wind shield.

The stainless steel pipes, bends, bolts, fixing sleeves, collecting sumps, etc., shall conform to relevant IS codes or BS:3605, and shall be procured, supplied, fabricated and erected in position by the BIDDER.

The sumps shall be of adequate size suitable lined with acid resistant bricks and provided with a RC roof and a heavy duty manhole cover. The effluent shall be led by means of stoneware pipe to the nearest manhole of effluent treatment system.

12.20 Louvres

Air outlet louvers shall be provided as per the requirement of this specification near the top. The louver fins shall be of Z-shape in cross section and made from anodized aluminium plates of a minimum thickness of 4 mm. The frame work supporting the louver fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvers shall be mounted in the

form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney wind shield. All panels must be approved by the EMPLOYER before installation. To outside face of louvers ST mesh on SST mesh frame work shall be provided.

12.21 Maintenance Provisions

The outer face of the chimney wind shield shall be provided with adequate number of stainless steel insert plates of grade 316 L at the top to enable fixing and supporting painter's trolleys and other accessories. The insert plates shall be provided with suitable number of threaded holes and nuts welded at the rear end to enable bolting of the assembly when desired.

Similar arrangement shall be made at each platform level but to fix the painting trolley arrangement directly on the platforms for the purpose of painting the internals of the chimney.

A lifting beam shall be provided at platform level to cater for lifting of materials during maintenance and painting. The size and capacity of the lifting beams shall be as indicated in relevant drawings.

12.22 Chimney Painting

The entire inside surface of the shell for full height shall be painted with four coats of acid and heat resistant black bitumen paint over a coat of compatible primer as per IS:158 with total DFT 150microns.

The top 50m of the outside surface of the shell shall be painted with 4-coats of acid and heat resistant paint (Polyurethane) over a coat of primer with total DFT 150 microns in alternate bands of signal red and white colour.

The remaining portion of the outside surface of the shell shall be painted with 4-coats of Synthetic enamel paint (IS:5410) with total DFT 150 microns over a coat of primer in alternate bands of signal red and white colour.

12.23 The laser scanning of chimney shell after every 70 mtr. height and on completion should be performed. Laser scanning shall be done for vertical check and entire shell surface profile.

12.24 Foundation

The chimney foundation will be resting on piles. Solid circular pile cap of uniform thickness shall be provided. The pile cap (min. M-30) shall be designed as rigid member with uniform thickness and no tapering of thickness shall be allowed. Minimum thickness of pile cap shall neither be less 0.09 times the diameter of pile cap or 0.4 times the overhang of the foundation beyond shell whichever is greater. Foundation diameter to depth ratio shall not exceed 12. Minimum reinforcement shall not be less than 0.12% in either face and in each direction. Wind and earthquake shall be treated as normal load and no enhancement of stress is permitted on this account in soil, concrete and steel. No tension will be allowed under the pile cap during earthquake and wind. Working stress method shall be adopted for design of foundation. Foundation will be designed for SRSS of moments of along wind response and across wind response. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. 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.

One intermediate layer of reinforcement in pile cap shall be provided where the thickness exceeds 2000 mm. Two such intermediate layers of reinforcement shall be provided where the thickness of pile cap exceeds 4000 mm. Such reinforcement in each direction shall not be less than 0.06% of cross-sectional area of pile cap.

Concrete pouring sequence shall be such that no cold joints occur.

The shrinkage reinforcement shall not be less than 16mm deformed bars at 600 mm centres. In addition, vertical chair bars at 600 mm centres shall be provided to support these bars.

12.25 Construction of Shell by Slip-Form Method

12.25.1 Shell construction has to be done by slip form shuttering technique. Type of slip form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

12.25.2 The Contractor should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Purchaser at the time of submitting tender. This statement shall include the following items:

- i) Type and description of slip-form equipment and its accessories
- ii) Design of scaffolding and staging
- iii) Description of materials including admixtures to be used for construction.
- iv) Manpower planning, construction spaces required, standby arrangement.
- v) Rate of slip-forming
- vi) Proposed workability requirement of concrete and type of cement and admixture to be used
- vii) Quality assurance programme
- viii) Method of transportation of material
- ix) Method of curing and rectification of defects
- x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.
- xi) Contingency solution for unplanned interruption
- xii) Time of completion

12.25.3 While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Contractor and minimum time of completion, apart from his past experience in such types of work as also technical and financial resources of the Contractor.

12.25.4 Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Contractor, while quoting for slip form method of construction.

- a.) Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps are advisable:
- i Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.
 - ii In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.
 - iii Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant IS specification) may be used for the purpose. An optimum ratio of coarse / fine aggregate should be established to suit the purpose depending on availability of aggregates.
 - iv Mix design also should be so done that it has a slump of 50mm at the point where concrete is placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 min. Suitable retarding agent and plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for Performance and for compatibility with particular type of cement Proposed to be used.
- Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40°C.
- b.) Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned to this work together with rectifying any defect.
- c.) Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken:
- i Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5mm.
 - ii Loading on slip form truss has to be fairly equal.
 - iii Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1mm to 1.5 mm around.

- d.) For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.
- e.) In designing the mix following aspects should be borne in mind :
 - i) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface of around 3600 sq.cm per gram.
 - ii) Coarse and fine aggregate should be well graded and rounded aggregates offer better performance in slip form technique. These help to keep down water / cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should be preferably be used unless reinforcement detailing calls for lesser size aggregates.
 - iii) From the creep point of view, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 kg per cum of concrete.
 - iv) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds should be between 0.1 to 0.2 Newton/sq.mm.
- f.) Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter – only in exceptional cases. Atleast two nos. standby vibrator units should always be maintained on top of working deck at all times during the entire period of slip form operation.
- g.) It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at greater heights. In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose.
It is always advisable to have a standby pump for effective utilization of the system.
- h.) If slip forming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.
- i.) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

It is desirable that jacking system, based on which the entire slip form system works, should consist of jacks 3 tonne / 6 tonne capacity and a hydraulic pump with necessary pipe connections.

Spacing of yoke legs should preferably be kept within 2 meters to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

Jacking rods should be of 25 mm diameter for 3 tonne jacks and 32 mm diameter for 6 tonne jacks.

- j.) Atleast 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.
- k.) In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.
- l.) For effective utility of this technique following areas need careful attention at the very conceptual stage:
 - i) Detailed quality assurance programme
 - ii) Advance planning and preparations
 - iii) Arrangement for on site supervision and adequate access facilities.
- m.) Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, descriptions and frequency of various checks and tests for slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared before hand by executing agency and to be approved by Engineer before starting the actual work.
- n.) Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slip form system.

- o.) It is desirable to have a break of atleast one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jacks rods etc.
- p.) Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. It felt necessary one hoist may be exclusively earmarked for transporting concrete.

For movement of personnel supervising the work a separate hoist must be arranged for.

- q.) The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.
- r.) Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

- s.) Proper telecommunication system has to be established between the personnel working on top of chimney and control room below.
- t.) A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

- u.) In case of interruption in the course of slipping of formwork following measures should be taken:
 - i) Provision of a key and additional reinforcement at the junction of new and old concrete.
 - ii) Slip form system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.
 - iii) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.
 - iv) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.
 - v) Neatly preferable the interface of old or new concrete as soon as it comes out of shutter panel.
- v.) It is preferable to suspend the construction work under high wind condition.
- w.) It is of utmost importance that for effective implementation of this system an Engineer fully conversant with slip form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.
- x.) Operation of slip form method of construction is a continuous one and it demands continuous / intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.
- y.) While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

- i.) Safety helmets and belts to be provided to all supervising staff and workers.
- ii.) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

- iii.) Hand railing and toe guard to be provided around all openings and platforms.
- iv.) Regular maintenance of equipment, checking of hoists, scaffolding etc.
- v.) Passenger hoist must have multiple ropes with adequate factor of safety.
- vi.) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the specification and to be operative in case of sudden power failure emergency standby generator must be kept ready during the entire period of slip form method or construction.
- vii.) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

12.25.5 Construction tolerances

The following shall be the limit of construction tolerances to be strictly adhered to by the contractor:

Wall thickness : (+) 10mm

Shell diameter : (+) 10mm for every 3m diameter without any abrupt changes but in no case more than (+) 40mm.

Verticality : 1 in 1000 subject to a maximum of 75 mm.

In addition, no two points 10m apart vertically shall be more than 20mm out of plumb w.r.t. each other.

12.25.6 Although deviations in general will not be encouraged, the Contractor, however may mention in his offer, the additions to or deviations from drawings/ technical conditions/schedule of items issued with the tender papers and any other special requirement implied with the adoption of the slip form method, which may include but need not be limited to the following items as applicable:

- i. Particular requirement of type and brand of cement, if any.
- ii. Special admixture to be added to concrete
- iii. Any change required in the geometry of the chimney including the shell thickness or side slope from that shown in the NIT drawing.
- iv. Any change/special requirement in the arrangement of reinforcement.
- v. Implications if any of necessary in-situ bending of rebars for /brackets etc. and straightening/cleaning of the same prior to casting of brackets.
- vi. Any additional constructional opening in the shell required at ground level for concreting.

All deviations from specification must be justified and tender price shall include all such variation / deviation. Such deviation without assigning any reason will be rejected.

13.0 NATURAL DRAUGHT COOLING TOWER

This specification is intended to cover design and construction of One (1) no. of Natural Draft Cooling Tower (NDCT) as detailed hereinafter for this project.

The scope shall include design, engineering, construction of natural draft reinforced concrete hyperbolic cooling tower complete as required for safe and trouble free continuous commercial operation.

It is not intended to specify completely herein, all details of design and construction of cooling tower. However, the design and construction shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation. All draings and documents shall be approved by before commencement of work at site.

The provisions of this specification are general in nature and cover broad aspects. This specification outlines the minimum requirements. However, it would be absolute responsibility of the bidder to collect, interpret, analyze all necessary information / data for the successful design and construction of the cooling tower. Structural safety and successful operation of the tower shall be the total responsibility of the bidder notwithstanding the approval of the owner.

13.1 System Description

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

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

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

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

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

13.2 Detailed Scope of Civil Works

- Excavation and backfilling for columns foundation and substructure below cold water basin level.



- R.C. foundation raft & Cold water Basin, R.C. Shell, R.C. support framework for fill support.
 - Hot water distribution duct.
- Painting of concrete surfaces shall be as per requirements mentioned elsewhere in this Chapter.
- Providing and installation of access doors in the shell of cooling tower including the necessary fittings and appliances on Tower Shell. The access doors shall be of heavy duty MS doors duly painted with 3 coats of epoxy paints.
 - Main access RC staircase outside the tower up to Hot water Duct top, internal RC walkways and platforms all with necessary galvanized MS pipe handrails.
 - Cold water channel outlet into gravity tunnel.
 - De-sludging arrangement for each compartment of cold water basin.
 - Provision of permanent access ladder up to top of tower manufactured in galvanized mild steel with adequate back-guards and landing platforms. The ladder shall comply with all applicable regulations.
 - Provision of peripheral drainage around cooling tower as mentioned elsewhere in this Chapter.
 - Necessary site clearing and grading all round the tower in accordance with specifications and drawings.
 - Water fill test of cold water basin, cold water outlet channel and tunnel.
 - Hydro test of Hot water Duct.
 - Supply and erection of all base plates, foundation plates, anchor bolts, sleeves, nuts, fasteners, embedded parts and any other likewise material required for all electrical and mechanical equipment and accessories to complete the work.
 - Rock anchors will not be considered for foundations in any case.
 - Preparation and supply of all working drawings required for the work:
 - Piling, excavation, dewatering, shoring and shuttering, backfilling around under ground structures and disposal of surplus soil outside the plant boundary / to the designated dump yard.
 - Any other works not mentioned herein, but sufficiently implied and are necessary for completion and proper functioning of the cooling tower.

13.3 Hot Water Distribution System

The distribution troughs/pipes shall be independently supported from the structures

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

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

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

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

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

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

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

13.4 Louvre & Casing

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

13.5 Cooling Tower Basin & Outlet Sumps

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

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

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

13.6 Civil and Allied Works



The civil design and construction of the cooling tower shall be in accordance with the technical specifications furnished in relevant Chapters of this Volume.

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

13.7 Civil Design Basis

13.7.1 Loading

The following loads shall be considered for the design of cooling towers:

- a) Dead loads
- b) Wind loads
- c) Earthquake forces
- d) Loads due to temperature and shrinkage effects. Temperature effects due to solar radiation shall also be considered.
- e) Construction load
- f) Foundation settlement etc.
- g) Any other load likely to come on cooling tower.

13.7.1.1 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, weight due to plugging/chocking of fills, 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. In addition, live load on the supporting structure due to maintenance activities related to fills /ducts/distribution system shall be considered.

13.7.1.2 Wind Load

The wind pressure on the tower shall be assessed on theoretical basis as well as with the help of Model tests in a wind tunnel of turbulent boundary layer.

All the theoretical methods outlined hereunder for estimating wind load 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.

For conducting model tests, bidders should survey the whole terrain and make their own assessment of likely critical wind forces & wind structure interaction. It would be the responsibility of the contractor 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 parameter shall be determined by the bidder and get the same vetted by the above agency/appropriate agency(s). Then with the help of physical model tests in a wind tunnel, offering appropriate aerodynamic similitude, the contractor shall obtain the most critical forces, stresses etc. with cooling tower at various levels and locations. Such model test shall also include all adjacent topographical features, buildings, and other structures which are likely to influence the wind load pattern on the tower significantly. 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 contractor shall have requisite experience and should have successfully carried out tests in the past for at least one cooling tower of similar capacity. The model tests shall be duly witnessed and approved by the Owner/consultant. The model test results shall be made available before final approval of the design.

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. Under the theoretical method, the circumferential net wind pressure distribution and wind pressure coefficient (p_1) for the tower shell (without meridional ribs) shall be obtained from the "Criteria for structural design of Reinforced concrete Nature Draft Cooling Towers IS: 11504-1985.

The above circumferential wind pressure coefficient (p_1) 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 (p_1) is the wind pressure coefficient as per IS: 11504-1985. Enhancement factor 1.43 is considered to take the interference effect of adjacent structures of significant dimensions into account. 10% increment shall be considered for imperfection in construction as per IS:11504. This factor shall be increased further by 10% during foundation design in absence of model test results. If the model is for C/L of shell, wind load shall be appropriately augmented to cater to the increase in diameter of the shell (O.D).

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) shall include 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, reference shall be made to "Criteria for Wind Resistant Design of Structures and Equipments" and as given below.

The wind pressure at a given height [$P(z)$] shall be computed as per the stipulations of IS: 875 (Part 3)-1987. For computing the design wind pressure at a given height the basic wind speed (V_b) shall be taken as $V_b=47\text{m/sec}$ at 10.0 meters height above mean ground level. For computing design wind

speed (V_z) at a height z , the risk co-efficient ' K_1 ' shall be considered as per IS: 875 (Part 3)-1987. For coefficient ' K_2 ', Terrain category ' 1 ' and class ' C ' as per table 2 of IS: 875 (Part-3) – 1987 (Latest) shall be considered. Coefficient ' K_3 ' shall be determined by taking into account nearby plant site and other features of the station & topography. The wind direction for design purposes shall be the one which would induce the worst load conditions. However, coefficient ' K_3 ' shall not be less than one (1) under any circumstances. The wind pressure at a given height shall be computed theoretically in accordance to the IS Codal position given as under:

$$P_z = 0.6 V_z^2 \text{ N/m}^2$$

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 & 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 KUHLTURME 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 (p_1) only. The wind pressure coefficient (p_1), as obtained from BTR after accounting for internal suction shall be multiplied by a factor of 1.43 to arrive at the net design pressure coefficient (p). The bidder shall furnish authorized English Translation of VGB-BTR KUHLTURME 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.

13.7.1.3 Earthquake Forces :

The seismic analysis shall be carried out in accordance with IS:1893 (all latest parts) 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 Clause 6.2.3.1 with an Age Factor of 1.0. 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 reference where the same has been successfully implemented.

13.7.1.4 Loads due to temperature effects

Stresses 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 4°C to 50°C. 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-axi-symmetric 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 also be designed for one sided solar radiation effect. Nevertheless an effective temperature difference of at least 250 C across the shell thickness constant over the height and follow 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.

13.7.1.5 Construction Load

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
- g) Tower crane fixings
- h) Works temporarily omitted for access purposes.

Any other load such as foundation settlement, etc.

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 unfavourable load combination.

13.7.1.6 Load Combination

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 + Se L + TL + SL
- f) 1.0 DL + 1.5 WL
- g) 0.9 DL + 1.5 WL
- h) 0.9 DL - 1.5WL

Where,

DL	=	Dead Load
WL	=	Wind Load
SL	=	Settlement Load
Se L	=	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 combinations as per relevant IS codes shall also be followed.

13.7.2 Tower Design Consideration

13.7.2.1 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.
- Analysis based on a recognized bending theory of the elastic shells shall be adopted for the design of the tower and supporting structures.

Regardless of analysis method adopted, the equilibrium checks of internal forces and external loads shall be performed.

- 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 complete tower for seismic forces by response spectrum method. Cooling tower shall also be designed for cross wind oscillations (wind induced vibration) if the fundamental natural frequency of the tower is less than or equal to 1 Hz. Frequency calculation for free vibration analysis shall also be furnished by bidder during detailed engineering.

13.7.2.2 Size and Shape

- The base diameter, air intake opening height, tower height and throat diameter shall be determined by thermal design consideration by the contractor 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.

$$H/D = 1.2 \text{ to } 1.55$$

Where H is the total tower height above basin sill level

$$H_b/H = 0.75 \text{ to } 0.85$$

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. Bidders 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.

13.7.2.3 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 wind gusts. Top edge shall be considered as a free edge in the analysis.

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 10o plan angle and of not more than 0.05 of the shell height.

- i) Meridional and circumferential direct stress resultants and the tangential shear stress resultants.
- ii) Meridional and circumferential bending moments.
- iii) Displacements normal to the shell mid-surface.

B. Buckling of Tower Shells

Critical dynamic pressure (wind pressure) at buckling shall be calculated from BS: 4485 Part-4:1996.

Buckling of Cooling Tower shell be checked as per Finite Element Analysis using software such as NISA 2, Ansys etc. The factor of safety for snap through buckling shall be more than 5. This requires non linear analysis including simulation of opening in the model. Alternatively, bifurcation buckling factor can be calculated using linear eigen value analysis with modulus of elasticity $E=0.8E_c$, to account for cracked section, with factor of safety more than 7.

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/BS 4485.

- 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. Opening 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 thickness of the shell shall be minimum 300 mm or more as per design.

E. Minimum Reinforcement in Shell Spacing and Placement

- The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415/500 conforming to IS: 1786 – latest. All reinforcement steel shall be corrosion resistant steel/HCRM. The minimum reinforcement to be provided shall be as follows:
- Top one third portion of shell: 0.4% of concrete cross-sectional area along circumferential direction and 0.35% of concrete cross sectional area along meridional direction.
- Remaining two-third portion: 0.35% of concrete cross-sectional area in both meridional and circumferential directions.
- Minimum bar diameter shall be 10 mm in transverse direction and 12 mm in meridional direction.
- Spacing of reinforcing bars should not exceed 200 mm in circumferential direction and 250 mm in meridional direction.
- The two layers of reinforcing meshes shall be adequately joined by S-hook over the total shell surface. At least two S-hooks in each square metre area of shell surface shall be provided. The hooks shall be of minimum 8 mm diameter bars.
- The concrete cover shall be 50 mm minimum. However, the clear cover shall not be less than 1.5 times diameter 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) Minimum thickness of shell excluding ribs shall not be less than 300 mm.

- b) Coefficients for pressure distribution around the cooling tower circumference including suction may be taken as per VGB-BTR KUCHLTURMEN SPECIFICATIONS (latest). All other factors including load intensification factors shall be as specified elsewhere in these specifications.
- c) Shell buckling and strength shall be checked as per clause-9.02.03 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 KUCHLTURMEN GERMAN SPECIFICATIONS (Latest) during detailed engineering stage.

13.7.2.4 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 raker column from superstructure considering various load combinations as specified in this document.

For selecting effective length of the raker columns, following restraints shall be considered:

- a) In case columns 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.
- c) The columns shall be designed based on working stress method except for the forces from DL + 1.5 WL which shall be designed as per limit state of strength method of IS: 456.
- d) The minimum size of raker column section shall be 1200 mm diameter or more as per design
- e) The size of pedestals shall be such that it will have minimum 200 mm clear projection from the raker column.

13.7.2.5 Crack Width Control

Under working stress method the maximum crack width of tower shell, lintels, raker columns, cold water basin and fill support structure shall be controlled up to 0.1 mm on basis of formulas as per IS:456-2000 and relevant British codes.

Fill support structures and Drift Eliminators shall be designed as per the load combinations specified in this document. Appropriate Live Loads and imposed loads shall also be considered in addition. The design shall confirm to limit state method as per IS: 456. For fill support structure, the design shall be done considering the weight of fills, falling water, plugging/scaling load and the live load due to the maintenance activities.

13.2.7.6 Pre-stressed Concrete Members

Design, construction and workmanship of pre-stressed concrete, members shall be in accordance with IS: 1343 (Latest revision). Steel wire for pre-stressing shall conform to IS: 1785 (Part 1) (latest edition) or IS: 6003 (latest edition). Crack width control shall be limited to 0.1 mm.

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. Wires shall be corrosive resistant. Concrete and grout used shall be sulphate resistant.

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

13.7.2.7 Liquid Retaining Structures

- a) The cold water basin including sludge pits, cold water channels, shall be designed as per IS: 456 (latest) with crack width control of 0.1 mm for outer face of the wall and inside face of the wall shall be designed as per IS 3370.

The structures shall be designed for the following conditions:

- i) Water filled inside up to maximum level and no earth outside.
 - ii) Earth pressure with surcharge load of 2.5 t/m², as applicable, and with/without ground water table at 1.0m below finished ground level outside and no water inside.
- b) The basin and associated structures shall be checked against uplift for basin empty condition. Stability shall be checked during construction stage as well as maintenance stage. The factor of safety shall be as per IS: 3370.
- c) Loads during construction, erection and maintenance stage shall also be considered.
- d) Temperature fluctuations from operation shall be obtained from the design data. Hot water temperature inside and cold air temperature outside shall be considered.
- e) Basin floor slab shall be designed to rest on piles or raft/mat foundation including fill-pack support structures. The stiffness of the subsoil shall be taken into account. The founding level of the raft/mat shall be either on virgin ground level or shall be placed at higher level only after scooping out filled up soil up to virgin ground and then filling back with well compacted sand (80% of relative density) up to the founding level of the raft/mat. The bidder shall ascertain the safe bearing capacity of the stratum at the founding level and may adopt the same subject to Owner's approval.
- f) Minimum thickness of basin slab shall be 300 mm with minimum reinforcement 0.35% of gross sectional area in both the directions. Reinforcement shall be placed in two layers, top and bottom surface. The effect of provision of flap valves/pressure release valves shall not be considered in the design of CW basin. In the space underneath the basin floor slab a layer of at least 100 mm thick PCC of mix 1:3:6 shall be provided.
- g) All reinforcements used shall be corrosion resistant steel/HCRM.
- h) The basin floor shall be cast in alternate bays in chequered pattern with sides not exceeding 4.5 meter
- i) No pressure relieve valve to be used at basin floor.

13.7.2.8 Water Distribution System

The structural design of the water distribution system shall consider the worst combination of following loads :

- a) Self weight, other imposed loads and live load.
 - b) Hydraulic pressures during normal operations including pressure surges.
 - c) Hydraulic pressure due to mal-operation of the tower or supply pumps.
- The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loading in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design. For the structural design the pressure level to be considered shall not be less than 1.5 times the design pressure.
 - The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature and ambient temperature.
 - The possibility of vibrations being imposed on the distribution system shall be investigated in the design. Seismic loading on the water distribution system shall also be taken into account.
 - The design shall be carried out based on uncracked section as per IS: 3370 under normal operating conditions. Strength check for worst loading including malfunctioning shall be carried out with stress limitations as per IS: 3370. The construction shall be completely water tight without the use of fillets, sealing compounds etc. The method of construction shall be such so as to avoid excessive rise in temperature of concrete due to release of heat of hydration.
 - Hot water distribution basin/trough/channel at top shall be covered by removable precast concrete slab to prevent direct exposure from sunlight. Corners of pre-cast concrete slabs shall be protected by angles. Lifting lugs shall also be provided for handling of concrete slabs.
 - Basin channel wall shall be designed for a minimum surcharge load of 25 KN/Sqm. Paving shall be provided all round cold water basin.

13.7.2.9 Platforms, Walkways, Stairways, Staircases, Internal Grillage etc.

These shall be designed as per working stress method IS: 456-2000 and IS: 800. The crack width in all RCC structures shall be limited to 0.1 mm. A minimum live load of 500 kq/sqm shall be considered for the design of all platforms, walkways, staircases etc. in addition to their own weight.

Platforms shall be minimum 1.2 M wide and walkways shall have 1.5 M wide.

13.7.2.10 Steel Structures

All structural steel members shall conform to IS: 2062 (GR-A). These structures shall be designed, fabricated and erected as per IS: 800 and other relevant Indian Standard codes for structural steel work. All steel structures shall be coated with anticorrosive system.

13.7.2.11 Slide Gates and Screens

Slide Gates and Screens, as per IS: 5620 conforming to IS: 2062 Gr. A, shall be designed for worst combination of operating and maintenance condition. All steel components shall be coated with anti-corrosive paint system. However, all guides of slide gates and screens shall be of stainless steel of Grade AISI 316L.

13.7.3 Foundations

Data specification sheet and Soil Report (By EPC Contractor) shall be referred to for selecting allowable bearing pressure to be considered in designing the foundation and in selecting depth of foundation. Cooling tower foundation is to be designed as strip foundation considering appropriate modulus of subgrade reaction. However, the bidder has to select suitable type of foundation compatible with the soil strata and calculated settlement of structure and foundation system. The bidder shall have to furnish conceptual design indicating type of foundation, general arrangement drawing for super structure, basin, pipe supports, pits, founding level etc. including settlement criteria complete with a design basis report with the offer.

The design of the cooling tower foundation structures shall be based on IS: 456 as per working stress method for worst load combination as per clause 9.01.06 In case of load combination DL + 1.5 WL, the limit state method as per IS: 456 shall be adopted.

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

While checking stability of the structures, neglect favourably acting loads from water fill, soil cover beyond the edge of the foundation. Ground water table shall be considered at 1.0m below Plant Finished Grade Level for design of foundations and all underground structures.

Minimum grade of concrete shall be M25 for foundation resting over 100mm thick PCC (1:3:6) layer. Clear cover shall not be less than 50mm.

Pile foundation shall be provided as per final approved soil investigation report. It is to be noted that part of cooling tower may have to be installed over existing abandoned ash pond. In that case special care has to be taken in selecting the type of pile, length & capacity of pile including any other special requirement for foundation system including basin as per specific recommendation of final approved soil report. Bidder must visit the site and assess the extent of existing abandoned ash pond area falling within proposed cooling tower before submitting his offer. It is to be noted that nothing extra shall be payable to the Contractor by UPRVUNL due to any variation in data assumed during preparation of his offer and execution stage.

Generally net tension should be avoided in the foundations/piles for the shell support foundation unless specifically permitted by the Owner.

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 structures will be subjected to following loading and extreme load combination case shall be considered for design.

1. Most critical forces transferred from superstructure for the various load combinations.
2. Uplift forces
3. Loading due to foundation settlement
4. Concentrated local loading from column nodes
5. Thermally induced local loading where supply culverts pass through the foundation structures without structural isolation.
6. Surcharge of 2.5 t/sq.m.

CW basin surcharge load shall also be considered in addition to the other relevant loads for the design.

13.7.4 **Fill Support Structures and Other Structures**

The self weight of the pack support structures shall be based on the weight of the packing including weight of standing, running and dripping water, other operation and plugging/chocking (debris/scaling) loads, etc. in accordance with manufacturer's data. In addition, a live load of 100 kg/m² shall also be considered for the design of supporting structures.

For other structures like walkways, platforms, etc. a live load of 500 kg/sq.m shall be considered. Hand railings shall be designed for horizontal load of 60 kg/m².

Wind deflector walls and any other structural elements shall be designed for a horizontal wind load of 80 kq/sqm or as per manufacturer's recommendations, whichever is higher. Thermal loading shall be as per manufacturer's recommendations. Earthquake loading shall be considered based on criteria given for cooling tower. Response spectrum analysis shall be considered.

Design of RCC members shall be based on IS: 456:2000 with limiting crack width of 0.1 mm.

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 structures including loads introduced by constructional equipments and crane deployed for fill supporting structure or shell erection.

13.7.5 **Requirements for Concrete and Reinforcement**

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

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

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

Structural concrete shall be of design mix complying with the relevant provisions of IS codes or any International Code of Practice as approved by the Owner.

Durability of the concrete shall conform to severe exposure category as per Table 3 of IS: 456 except noted specifically otherwise.

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

All reinforcements used in RCC structure shall be corrosion resistant. Column reinforcing bars shall be carefully anchored in the shell and foundation. The anchoring length shall not be less than 80 times the diameter of the bars.

All foundations structures shall be provided on all sides with a minimum reinforcement of 0.12% of gross cross-sectional area distributed over top and bottom faces.

The minimum grade of concrete of structural components of cooling towers shall be as follows in accordance with IS: 456.

a)	Shell and Raker Columns	:	M-30 grade
b)	Pre-cast pre-stressed elements	:	M-30 grade
c)	All other RCC concrete	:	M-30 grade
d)	PCC encasement concrete except piles	:	M-25 grade
e)	Piles (with OPC/PPC/PFC)	:	M-30 grade
f)	Tower foundation	:	M-30 grade
g)	Mud mat/lean concrete PCC	:	M-10 grade

Coarse and fine aggregates shall be specially selected to ensure that they are not susceptible to alkali/chloride attack or prone to disintegration at high temperatures. In particular limestone aggregates shall never be used. The maximum size of coarse aggregate shall not be larger than 1/8th narrowest dimension between reinforcement bars not more than 20 mm.

Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means as directed by the Engineer-in-charge.

The water cement ratio by weight shall be 0.45 maximum including free moisture in the aggregates, and slump should be suitably decided to provide good quality concrete work.

13.7.6 Admixtures

Admixtures may be permitted to be used in accordance with relevant IS codes to modify the rate of hardening or setting, to improve workability or as an aid to control concrete quality and protection to reinforcement bars against corrosion. The Owner reserves the right to direct the contractor to conduct laboratory tests or use test data, or other satisfactory reference before granting approval. The cost of all tests conducted shall be borne by the contractor. The admixture shall be used in strict accordance with the manufacturer's directions and/or as directed by the Owner. No extra payment will be made to the contractor on account of using admixtures.

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 rodding. Particular attention shall be paid to accurately shape the corners at all openings.

Point of discharge of the concrete in to the forms be 1500 mm max. above the concrete surface. Concrete shall be deposited in approximately level layers not greater than 400 mm deep unless permitted otherwise.

Concrete in the cooling tower shell in each lift shall be so laid that the no. of vertical or inclined construction joints are minimized to the extent possible. Horizontal construction joints shall be maintained at uniform spacing throughout the height of the cooling tower as per the directions of the Owner.

Special attention shall be paid to proper curing of vertical faces of the cooling tower shell so that these do not remain dry. All thin walled structural members shall be protected by means of curing agents. It is recommended to use a curing agent for the cooling tower shell providing additional protection like a single transparent cooling with a material based on vinyl mixed polymer. Inside face of the shell should be protected by a second pigmented coating of the same base material. Any other method of curing, if permitted by the Owner may be used.

Sampling and testing of concrete shall be carried out as stated in Technical Specification elsewhere and as per relevant Indian Standard Codes. However, following minimum tests shall be carried out, irrespective of whatever stated otherwise:

Test of compressive strength

Columns – 1 Set of 3 cubes per column

Shell-2 sets of 3 cubes per climbing section

13.7.7 Cover to Reinforcement

Unless indicated otherwise the clear concrete cover for reinforcement shall be as per IS Codes.



The correct cover shall be maintained by cement mortar spacers/cubes or other approved means, reinforcement for footing/pile caps, grade beam, and slabs on sub-grade shall be supported on pre-cast concrete cover block as approved by Engineer-in-charge. The use of pebbles or stones as cover blocks shall not be permitted.

The 28 days crushing strength of cement mortar cubes/pre-cast concrete cover blocks shall be at least equal to the specified strength of concrete in which the cubes / blocks are embedded.

The minimum clear distance between reinforcing bars shall be in accordance with IS:456 (latest edition) or as specified elsewhere in this specification.

All lapping of reinforcement bars in the cooling tower shell shall be by lapping as per relevant codal provisions. Prior approval of the Owner shall be taken for deciding the method of lapping the reinforcement bars in the shell.

13.7.8 **Checking of shell geometry**

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

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

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 lift.

The shell shall be constructed within the dimensional tolerances as stipulated in clause 7.3 of IS: 11504. If the permissible dimensional tolerance are exceeded, the Owner 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 Owner 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 Owner, for approval, before construction will be permitted to proceed.

If in the opinion of the Owner the calculations show that the integrity of the shell could be threatened, the Contractor will be required to submit to the Owner 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 1m of height. Any such adjustment shall be made with full knowledge and consent of the Owner.

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 Owner prior to commencing the next shell pour.

The contractor's shell construction procedures shall include for providing the Owner with the facilities and a reasonable time period as may be required to carry out an independent check of the completed works.

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.

All piling work shall be carried out by specialist subcontractor approved by the Owner. Initial pile load test shall be carried out for at least 3 sets of piles for direct compression and lateral load.

Since the effective action of the piles will depend on the adopted method of construction, the contractor shall guarantee that the piles, as constructed by the sub-contractor, shall effectively transmit the maximum loads which can be imposed on the foundation soil and corresponding maximum deflections.

13.7.9

General Requirements

- a) The basin slab 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 I) (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.
- b) PVC water stops shall be provided at all construction/ expansion joints of water retaining structures. 230 mm (min) wide and 10 mm (min) thick approved quality PVC water stop with central bulb shall be used where expansion joints are envisaged.
- c) The basin floor of each compartment shall be provided with a slope of not less than 1 in 120 towards sump for dewatering. 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 sluice gates (rising spindle type) conforming to IS: 3042 or sluice valves shall be provided in the drain chamber or any other arrangement specified elsewhere in the tender document. Suitable operating platform with access ladders for operating the gates or valves and pipes, shall be provided in the drain box.
- d) A 250 mm high sill shall separate the pond floor from the tower outlet.
- e) 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.

- f) Fill will be of film type supported on RCC beam. Film fill should be characterized by reduced air pressure losses, and shall not susceptible to clogging. Design and facing of the film fill shall be such as to expose high air/water surface with minimum air pressure drop.
- g) The sluice gates shall be structural steel with anti-corrosive coating specified elsewhere. Number of sluice gates and removable screen shall be two (2) per tower. Proper rubber seal shall be provided so as to avoid any leakage of water. The rubber seal provided for the sluice gates be tested in accordance with the relevant Indian Standard Code. Sluice gates 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 sluice gates and screens.
- h) Lean concrete below foundations, cold water basin, other liquid retaining structures and all underground structures, unless noted otherwise shall be at least 100 mm thick.
- i) The R.C.C. structure of the Cooling Tower shall be painted on the exterior surface with two (2) coats of water proof cement paint of approved make and colour .

The interior surface of the Cooling Tower structure and the interior face of the Cooling Tower Basin, fill supporting beams, columns and bracings, raker columns etc. which are in contact with water / moisture shall be painted with one coat of primer and two coats water proof bituminous paint conforming to IS:3384 and IS:9862 respectively.

- j) Unless noted otherwise all concrete surface which are in contact with the earth shall be applied with anticorrosive coat system.
- k) 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.
- l) 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 intervals unless approved otherwise. The stair shall have risers not exceeding 125 mm and treads 250 mm minimum. Anti-skid nosing at each step shall be provided.
- m) Minimum size of all doors shall be 2100 mm high (clear) and 1200 mm wide (clear). The door shall be of steel with anti-corrosive coating of polyurethane as specified elsewhere. However, FRP material or equivalent may also be used subject to approval of the Owner. The door shall be air tight when closed.
- n) The hand railing on both sides of the staircase shall be galvanized with three 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 1.2 m centers. The top hand rail shall be at 1000 mm above the steps with an intermediate

member at 550 mm height. The posts and runners shall be welded construction with round corners. Complete hand rail shall be applied with anticorrosive coating system as specified elsewhere. All galvanization works shall have 610 gm/sqm of deposit.

- o) Approved 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. The clear width of walkway shall be 1.5m and clear head room shall not be less than 2 m. Radial gaps of 12 mm wide shall be provided at intervals in the walkways for discontinuity.

A reinforced concrete platform of 1500 mm clear width shall be provided around the tower 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.

- p) Hot double dip galvanized handrails as described above shall be provided on all sides where there is a risk of falling through the fill.
- q) 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. 12 mm wide radial gaps shall be provided in the platform at suitable intervals for discontinuity. Adequate MS embedment shall be provided in each side of platform to facilitate maintenance of tower shell.

Two (2) diametrically opposite galvanized MS caged ladders, 600 mm wide, made out of 6 mm, x 10 mm flats for full height of the tower shall be provided as per IS: 3696.

- r) MS rung ladders shall be hot dip galvanized ladder shall be 600 mm wide fabricated out of 60 mm x 10 mm flats with 20 mm dia. rungs at 300 mm centers. Stays shall be provided at every 2.25 m intervals connecting the ladder with the concrete shell. Upto throat level these ladders shall be on the exterior surface of the cooling tower and shall be continued along the inside surface of the tower up to the top of the tower.

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

A RCC landing of size not less than 750 mm x 1500 mm, with galvanized handrails and galvanized steel door to be provided at the throat for interchange. Intermediate landings of reinforced concrete of size not less than 750 mm x 1500 mm shall be provided at every 8 to 10 m height of the ladder.

Some of these 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. The ladder leading

to the top platform shall have approach from ground via the RCC staircase.

- s) In order to provide approach for maintenance of shell (inside & outside faces), all platforms shall have 20 mm wide radial openings in the platform floor 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.
- t) All exposed structural steel work used in cooling towers shall be hot double dip galvanized unless it is coated with a separate anti-corrosive coating system. The minimum coating shall be 610 gm/sq.m and shall comply with relevant IS codes. Galvanizing shall be checked and tested in accordance with IS: 2629. Galvanization shall be followed by the application of an etching primer and anticorrosive hibuild epoxy coating system of DFT 260 microns. 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 AISI 304 or equivalent.
- u) Mix proportion in Cement-sand mortar for brick masonry work shall be 1:6 for 250 mm thick brickwork and cement-sand mortar (1:6) shall be used for 125 mm and 75 mm thick brickwork. Thickness of 1:6 cement-sand plaster on brick masonry shall be 18 mm for outside, 12 mm for inside and thickness of 1:4 cement-sand plaster shall be 6 mm for ceiling.
- v) Materials for precast concrete components including joint fixing, lifting hooks and other exposed steel components shall conform to technical specification and other points mention in the document.

13.7.10 Grating

Steel gratings, where required, shall be fabricated out of 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 nosing in an approved manner extending up to 100 mm above the walkway surface. All steel gratings shall be galvanized and applied with anticorrosive coating specified elsewhere.

13.7.11 Paving

The finished ground level shall be paved for 3.0m width all round the outer edge of the cold water basin. The paving shall consist of 150 thick RCC slab of M-20 grade over soling. The minimum reinforcement shall be 10 mm dia spaced 150 mm center to center both ways top and bottom. The RCC slab shall be overlaid 100 mm thick M-10 PCC mat and 300 mm well compacted sand layer. All around peripheral RCC drain leading to drain chamber shall be suitably provided.

13.7.12 Fittings and fixtures



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

13.8 Drawings, Data and Calculation to be submitted by Bidder :

For list of drawings, data and calculation to be submitted by Bidder before and after award of Contract refer Chapter-18 of Volume-III of this specification.

13.9 Codes and Standards

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

- BS 4485 Water Cooling Tower (Part 1 thru' 4)
- Cooling Tower Institute of USA, Bulletin ATC-105: "Acceptance Test Procedure for Water Cooling Tower."
- PTC-23: ASME Performance Test Code for Atmospheric Water Cooling Equipment.
- IS: 11504: Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Towers.
- American Society of Testing Materials
- The materials of various components such as PVC, plain and reinforced concrete, bars and steel wires for concrete reinforcement etc. shall be in accordance with relevant Indian Standards or else to applicable American Standards.

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

a)

14.0 Plant Coal Handling System

Plant coal handling will consist of junction towers, under ground tunnels, pent house, conveyor galleries, trestles, MCC room, wagon tripper, wagon tripper shed, track hopper, pump house, raw water tank for water supply, crusher house, stacker reclaimer foundation, coal stock pile, stock yard drainage, water sprinkler system, dust extraction system etc.

Necessary statutory clearances / approval from Railways / Highway Authority / PWD shall be obtained by Contractor at his own cost

14.1 Wagon Tippler, Machinery Hatches, Reclaim Hopper and Underground Tunnel

The substructure (below ground level), its supporting enclosure structures/basement shall be of reinforced cement concrete (RCC). Cross beams supporting the railway track over the hopper may be provided at suitable spacing considering easy flow of coal. Suitable supporting RCC Foundation system for Side Arm Charger shall be provided as per design requirements

The top edges of the cross beams shall be chamfered for smooth coal flow and shall be provided with removable abrasion resistant steel liner plates (Min. 16 mm thick) e.g. TRISCAL/SAILHARD or lined with 50 mm thick guniting (shotcreting). The overall depth of the above cross beams shall be restricted to a maximum of 1.5M. The walkway floor shall have non-skid finish. Water proofing for substructures shall be done as per specification. The hopper wall in no case shall be in contact with earth/backfill irrespective of whatever shown in tender drawings.

The superstructure of wagon tippler shall have structural framing with provision of electric traction wire for electric loco. The roof and side sheeting shall be single skin metal cladding system comprising of profiled sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zinalume steel (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The metal cladding shall have 500 mm cover width, 47 mm high crests at 250 mm centres with special male / female side laps and anti siphoning feature to prevent leakage with provision of minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light and louvers for ventilation purpose. The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & also to be provided 15 % of floor area in a staggered fashion on the roof.

Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. Steel gratings of mesh size 350 mm x 320 mm for wagon tippler hopper shall be provided. The grating shall be built of min. 250mm x 28mm thick flats in main direction and min. 125mm 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. Provide continuous standard G.I. hand railings on one side covering the entire length of the hopper fulfilling requirement of railway clearance to prevent any person falling inside.

The internal hopper surface shall be finished with 16mm thick TRISCAL/SAILHARD liner or lined with 50 mm thick guniting (shotcreting). All faces of structural concrete coming in contact with coal e.g. top, bottom & side of beams etc. shall be provided with 16mm thick TRISCAL/SAILHARD liner as specified or lined with 50 mm thick guniting (shotcreting).

All structures of Wagon Tippler complex under influence of railway loads shall be designed for static/moving loads of locomotive and wagons. The number of locomotives and wagons with capacity, design axle load, braking force, impact factors etc. shall be considered for design as per latest system requirements. Indian Railway Code of Practices shall be strictly adhered to for design. It shall be the responsibility of the contractor to get the designs and drawings of structures under railway loads approved by Railway authorities. For portion of structures without Railway loads the structure shall be designed for Earth & Water Pressure, Surcharge Pressure, uplift, material load, seismic and wind force. Paddle feeder table shall be provided with abrasion resistant steel liner cover plate e.g., TRISCAL/SAILHARD or lined with 50 mm thick guniting (shotcreting). The thickness of such liner shall not be less than 16 mm. All edges of concrete shall be provided with edge protection steel members and thickness of such members shall not be less than 8.0mm. Floor shall be provided cross slope towards side drains. Cross slope shall not be more than 1:50. Side drain shall be sloped towards sump where sump pump shall be provided. The slope of the side drain shall not be more than 1:400. Concrete surface in contact with soil shall have water proofing treatment as per specification.

Minimum thickness of R. C. C. raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top. or with 50 mm thick guniting (shotcreting) Water proofing / Damp proofing of under ground portion of Wagon tippler 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 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. 50mm thick P.C.C. (1 : 2 : 4) with 10mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

14.2 Underground Tunnels for Conveyors

All under ground tunnels shall be of RCC considering box sections. The roof of the tunnel shall be straight. The profile of the tunnels shall match with profile of conveyor. The tunnels shall have side and/or central walkways of required width as per Mechanical system requirement. The tunnel shall have water proofing as mentioned in Cl. 14.1 above. **Contractor shall ensure that no seepage water shall enter the tunnel. All necessary treatment shall be ensured by the contractor.** Floor shall be non-skid type and shall be provided with proper slope to drain out water by means of drains, running along the length of tunnel and connected to sumps. Arrangement shall be made for disposal of this water upto the inlet of coal slurry settling basin. The drain shall be provided with M.S. pressure locked type (preferably electro forged) galvanized grating manufactured in accordance with applicable Indian Standard. RCC (M-20) steps shall be provided where the inclination is more than 8 degree inside portion of tunnel. The risers for walkway steps shall not exceed 150mm. Continuous Hand rails of 32 NB GI pipes shall be provided along both side walls. Sufficient insert plate shall be provided at the side walls & roof soffit of the tunnel for Mechanical/Electrical requirements.

The tunnel shall be designed for Earth & Water pressure, surcharge load or load due to Coal pile/Bulldozer/Railway loads (as applicable) whichever is higher, over burden etc. Tunnels below roads shall be designed for Bulldozer or Class A/Class-AA loading (as per IRC) whichever is critical. Necessary approval for designs of tunnels under influence of Railway loads shall be obtained by the Contractor from Railway authorities. Tunnels for Conveyor shall be designed for additional loads due to coal pile of 8.0m high, bulldozer loads or a combination of above whichever is critical.

14.3 Underground Transfer Points / Houses

All underground transfer points shall be of RCC construction with waterproofing as per Cl. 14.1 above. The intermediate floor and basement floor shall be provided with floor finish as per specification. Other requirement for design loading and internal drainage etc. shall be alike underground tunnels described above. In all underground structures the drain shall be minimum 250mm depth. All internal drains shall be provided with min 40mm thk. M.S. electroforged galvanized grating above.

All underground TP's shall be provided with minimum 1.2m wide R.C. stair with hand railings as per specification. Risers for steps shall not exceed 180mm and tread width shall not be less than 250mm. Hand rails shall comprise of 32 NB M.S. galvanized pipe 1.1m high verticals not exceeding 1.5m (max) c/c with 2 nos. 32 NB M.S. galvanized pipe horizontal placed at top and mid height respectively and continuous flat iron toe guard at bottom.

14.4 Overhead / Ground Conveyor Galleries and Trestles

On grade and over ground galleries shall be of enclosed type. Walkways in the conveyor gallery and clear height of gallery shall be provided as per the

approved Mechanical General Arrangement layout of CHP. A continuous slit opening of 500 mm height shall be provided on both sides of gallery just below roof sheeting. The gallery shall be made of structural steel with galvalume sheet cladding on roof and sides as mentioned in Cl. 14.1 above and minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet (size 1.5m x 1.5m) of approved make at 6.0m interval along the gallery for adequate natural light on roof and walls to be provided.

The floor for on-grade galleries shall be raised at least 500 mm above finished grade level and paved with minimum 150 thick RCC (M-25) over 100 mm thick lean concrete (M10) over 230 thick boulder/stone pitching interstices filled with sand. The raised floor shall be retained by continuous brick walls at both sides of enclosures running along length of the conveyor and the surface of the wall shall be plastered and finished with cement based paints externally. Conveyor Gallery structures shall be designed considering both conveyors operating simultaneously. All gallery-supporting trestle shall be so proportioned that the transverse deflection of gallery due to wind/seismic load should not be exceeded height/1000 as stipulated in IS:11592. Overhead conveyor will be located in a suitable enclosed gallery of structural steel and will consist of two latticed girders having rigid jointed portal frames at both ends. The latticed girder will be braced together in plan at top and bottom. Roof truss will be provided at upper node points of latticed girder to form an enclosure. 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. The maximum span of gallery will not exceed 25 m unless higher span is required due to site condition subject to the approval of Owner. In case length of Conveyor Gallery exceeds 25m dynamic analysis shall be carried out for the same. 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. Sliding PTFE bearing supports shall be provided at one end of the gallery for relieving forces due to temperature variation. Accordingly for the purpose of analysis one end of the gallery shall be taken as hinged and other on roller. Hand railing should not be supported on conveyor supporting stringer.

For ground conveyor, all portals will be placed at a maximum spacing of 6.0 m.

For Conveyor Galleries washing water downcomer shall be provided at every Trestle location.

The conveyor trestle legs in CHP area shall be encased with R.C.C. (M-25) upto 1.5 m from finished ground level.

All trestles having height more than 20.0 m will preferably be 4 legged. Adequate four (4) legged trestles shall be provided to take care longitudinal forces in conveyor. Four (4) legged trestles will be placed at a maximum interval of 90.0 metres and an emergency caged ladder up to ground level at every four-legged trestles except stair locations on both sides of galleries shall also be provided.

Walkway portion of overground conveyor galleries shall be of minimum 6 O/P chequered plate construction with anti-skid steel bars (10 mm) @ 500 mm along the length of gallery below 8 degree inclination of conveyor gallery.

However, for inclination more than 8 degree, chequered plate steps shall be provided with toe guard. For both sides & Central walkway continuous hand rail shall be provided as specified elsewhere. Number of walkways in single stream and double stream conveyor galleries including their widths shall be as per approved mechanical GA drawings. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 3 mm thick seal plates in such a way that complete gallery bottom shall form a leak proof floor. The seal plates shall conform to IS : 1079 (semi-killed quality).

Roof, side sheeting and slit opening on walls for over-ground conveyor galleries shall be similar to ground conveyor explained above. The area for natural light shall not be less than 15% of floor area. 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. Crossover shall be provided at intervals not exceeding 100m c/c & stair up to the ground floor level shall be provided at every location of crossover. Crossovers shall preferably be located over four-legged rigid trestle location. Platforms for cross over shall be provided with chequered plate flooring and hand railing as per specification. The foundations & structures for gravity take up with platform and hand railing shall be provided by the bidders as per drawing and specification. Fencing with lockable gate shall be provided around Gravity take ups. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles adjacent to boiler house and railway lines shall have to be decided carefully so that there is no interference (both underground and over-ground) with other buildings, equipment/equipment structures foundations nearby as well as railway lines, ducting, trenches, drains etc. Adequate clearance required by Railway authorities shall be maintained. The Contractor shall have to execute work very carefully so that any existing foundations are not damaged. Execution and erection sequence of foundation for trestles and galleries or any other coal handling plant equipment and structures has to match erection sequence of boiler, ESP or other adjoining structures.

In Bunker floor, necessary pockets, inserts, bolts etc. for conveyor and equipment supporting structures will be kept at floor level based on the requirements of conveyors and as indicated in the drawings.

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

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times \frac{1100}{800}$$

It should be noted that for structural design, unit weight of coal shall be assumed as 1200 Kgs. / Cu. M. instead of 800 Kgs. / Cu. M. considered for system sizing purpose.

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.

OR

- b) In between transfer houses / buildings, four legged trestles shall be placed at a maximum interval of 90 metres. 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.

Piling shall be used for foundation of trestles supporting overhead conveyor galleries.

14.5 Overground Transfer Houses



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



All overground TPs shall have R.C. foundations resting on firm strata. The superstructure for TPs shall be structural steel framed with adequate bracing arrangement. All intermediate floors and roof shall be of RCC having minimum 150 mm thickness. The ground floors for buildings shall be of RCC over PCC sub-base over minimum 230 thick compacted boulder/stone soling. The RC floors shall be provided with floor finish as per specification and roof shall be provided with heavy water proofing treatment as per specification. The cladding shall be of brick work plastered on both faces up to 3.0 M from lowest working floor and remaining height with 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel sheet (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side and all as per manufacturers specifications whichever is higher. Sheetting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners. The clips shall be concealed and no fasteners are to penetrate the sheetting. Height of plinth shall be 500mm from ground level and RCC pedestals for column shall be 300mm above floor level. In all the floors steel column shall be encased with R.C.C. of min. grade M-25 with minimum reinforcement upto 300 mm from respective floor. Adequate windows and doors shall be provided as per specification. 150 mm high (from finished floor level) x 125 mm wide RCC curbs shall be provided around the openings.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors with at least 20% of cladding area.

TPs shall be provided with independent steel stair block with steps of M.S. grating from ground to roof with access to roof. The width of the stair shall be minimum 1.2 m. The tread shall be minimum 250mm and riser shall be uniform throughout the height and not exceeding 150mm. Continuous handrails shall be provided in stair. RCC parapet of 900 mm height shall be provided. Adequate provision shall be made for roof drainage. Roof shall be provided with 150 dia. M.S. rain water down comer pipes. Steel doors, steel windows (with Chajjas/fins) as well as access and stair ways etc. shall also be provided.

The transfer point structures shall be so designed that the transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of the conveyor supporting trestle. 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.

All Transfer Houses having monorail projection outside the building for maintenance shall be provided with steel door.

Metal deck sheets may be used as permanent shuttering in RCC floors, if so desired.

Piling shall be used for foundation of transfer houses.

14.6 Crusher House & Crusher Foundation

The Specification for Crusher house are similar to over ground TPs mentioned above except cladding area of Polycarbonate sheeting.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors covering at least 25% of cladding area.

The crusher house shall have an independent stair with access to roof for general use like other TPs. In addition, it shall have a separate stair block for fire escape suitably located complying with fire fighting norms of TAC. Full brick thick wall to be placed in suitable structural frames for stability and safety between two crushers in full height with a provision of a door.

Floors shall be of R. C. C. (minimum 150 thick) 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 of R.C.C minimum 150mm slabs.

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. The transverse deflection of the frames and deflection of the beams (other than vibration isolation supporting structures) shall be same as transfer point structures.

Metal deck sheets may be used as permanent shuttering in RCC floors, if so desired.

Piling shall be used for the foundation of crusher house.

14.7 Stacker Reclaimer Foundation

Stacker - 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 loads as furnished by the equipment supplier.

Piling shall be used for the foundation of stacker reclaimer.

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.

14.8 Coal stock yard

Entire area shall be excavated to average 300mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller. 100mm thick river sand cushion layer shall be placed over compacted subgrade and consolidated by flooding. 150mm thick boulder soling shall be laid over sand cushion with joints filled with river sand. Over boulder soling, 75mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 200mm thick RCC slab of grade M20 having double layer reinforcement. Actual thickness of RCC pavement shall be designed considering weigh of coal and dozer movement. Slope is to be maintained through all layers. The coal stack area shall be graded with suitable slope for draining the surface by longitudinal drains which shall be of RCC trenches with graded gravel packets at about 1.5m intervals on the sides to trap coal dust. Weep-holes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal rains for discharging into the main surface drain to be provided by the Contractor by the side of the road. Retaining wall of 1.0 m height shall be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stack area should take care of loads arising due to dozer movement and shall be designed to sustains coal water pressure.

14.9 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.

Toilet facilities with toilet fixtures and drinking water supply facilities shall be provided. All doors of toilet shall be of standard PVC door of approved make & colour. The effluent for sewer shall be treated in sewer treatment plant.

Pile / open foundation shall be provided as per soil condition at site.

14.10 Pump Houses

Pump House shall be of R.C.C framed structure. Cladding shall be of fly ash bricks with plastering on both sides. Roof shall be provided with water proffing treatment as specified elsewhere. Underground sump shall be of R.C.C. Galvanized steel ladder shall be provided for access to the roof of pump house and water tank.

Pile / open foundation shall be provided as per soil condition at site.

14.11 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.

14.12 Toilets

Toilet with potable water line facilities shall be provided in each of the following locations:

Crusher House (Ground Floor)

In all M. C. C./ Control Room building

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 1 No. counter & stainless steel sink.

14.13 Staircases

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.

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 metre 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 610g/m².

Outside stairs to transfer points shall be open type. However sheeting shall be provided at the top.

Stairs of MCC/control room, reclaim hopper 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/ reclaim hopper/underground TP's.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies.

14.14 Trenches



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



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.

14.15 Drainage & Water Supply Works

14.15.1 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 drain, which will lead the discharge finally to the coal settling pond.

For Crusher House, Pent Houses & TP's in stock pile area, each down comer shall lead the water / coal slurry into the peripheral drains (Brick 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 (Brick 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 reclaim hopper, peripheral drains (Brick 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 (Brick 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.

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.

14.15.2 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.

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 and runoff coefficients as mentioned in Chapter-21 of this specification. All buildings (including transfer houses and crusher house) shall be provided with open surface brick drains of minimum size of 300 mm width and 300 mm depth all around the periphery. All drains excepting the peripheral drains around the transfer points, crusher house, control / M. C. C. buildings, pumps house etc., shall be of R. C. C. construction. 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 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 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.

For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch.

14.16 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 / JT's / Crusher House 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 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 1000 mm in place of P. C. C.

14.17 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.

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 230 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 150 mm thick R. C. C. of grade M-25 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 reclaim hopper, 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 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 reclaim hopper, 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 above the finished grade / formation level as per CEA guide lines.

14.18 Fencing

Refer relevant clause No. 6.14 of chapter 6.

14.19 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.

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 & 75Kgs. / sq. m. on inclined roofs shall also be considered.
R. C. C. floors	500 Kgs. / Sq. M.
Stair and balconies	500 Kgs. / Sq. M.
Toilet rooms	200 Kgs. / Sq. M.
Chequered plate floors	400 Kgs. / Sq. M.
Walkways (including walkways in conveyor/cable galleries)	300 Kgs. / Sq. M.
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.
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.
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.
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.
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 superimposed loadings with minimum factor of safety of 1.2 against buoyancy.
Unit weight of coal shall be taken as 1200 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.	

14.20**Design Criteria**

1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



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, under ground 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 (latest).

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.

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 through the shear key arrangement.

Base plate for trestles shall be designed as gusseted base with shear lugs to transfer horizontal forces. Anchor bolts shall be designed for uplift forces only.

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 all other underground structures not in contact with liquid on inside face may be designed as cracked sections with crack width limited to 0.1mm for both faces.

For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining finished 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.

14.21 Shotcreting

14.21.1 General Requirements

Generally, shotcreting shall be done in accordance with IS : 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

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.

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.

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.

14.21.2 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.

14.21.3 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.

14.22 Vibration Isolation System

These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal crushers (ring granulators).

14.22.1 Supporting Arrangement

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".

14.22.2 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 at least five years.

14.22.3 Engineering

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 includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the coal crusher.

Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.

Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.

Drawings showing embedments and their locations and details on the R. C. C. top deck.

Drawings showing blockouts, recesses etc. on the top deck.

Design of the supporting structure, including preparation of detailed drawings and bill of materials.

14.22.4 Supply including packing and transportation to site

Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

Frame (s) for pre-stressing of spring elements.

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.

14.22.5 Erection and Commissioning

Complete erection and commissioning of the vibration isolation system including:

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.

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.

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 specifications should be referred to.

14.22.6 Documentation

Submission of detailed design calculation, analysis (Static and dynamic) and drawings for Employer's acceptance and approval.

Furnishing methodology of providing shuttering and its removal as well as concreting of deck slab, installation of springs and the sequence of operation.

Furnishing installation and maintenance manual indicating equipment, procedure etc., necessary for installation, maintenance of vibration isolation system.

Furnishing a check list for confirming the readiness of the civil works for the installation of vibration isolation system and equipment required at each stage installation.

Bill of materials of various elements such as springs, visco-dampers, with their rating, stiffness etc., included in supply.

Detailed specifications of the vibration isolation system and various items included in the supply and the standard (local or international) to which they conform.

Proposed erection strategy of the entire system.

14.22.7 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 spring idealized with vertical and horizontal stiffness's. 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 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 to 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 by the isolation efficiency criteria and de-coupling required.

The first bending mode frequency of the top deck shall be at least 20% above the operation speed.

Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

Balance quality grade Q40 as per VDI 2060-1966.

One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non – drive end of the crusher.

Three hammers broken condition. All the three hammers broken shall be assumed to be the same suspension bar and located at the non – drive end of the crusher.

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

1) Operating Speed of 750 RPM

150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 - 1966.

300 microns in case of one hammer broken condition.

Amplitudes need not be checked for a three hammer broken condition.

2) Operation Speed of 450 RPM

200 microns for an imbalance force arising out of balance quality grade Q40 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 operation speed between 450 to 750 RPM the amplitude can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical pins on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavorable super position 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 a 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 :

- a) Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavorable combination shall considered for design.
- b) 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
- c) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

- d) Working stress method shall be used for the design of R. C. C. deck. In survival condition, 10 % overstressing may be permitted.
- e) The R. C. C. top deck shall be at least of M25 grade of concrete as per IS : 456 - 1978.
- f) Fatigue need not be considered for the three hammer broken condition.
- g) 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.

15.0 ASH HANDLING SYSTEM

15.1 Specification for Civil, Structural and Architectural Works will be referred

Ash handling system shall comprise of bottom ash and fly ash handling systems, ash slurry pump house and ash compressor house, ash water pump house, combined slurry/high concentration slurry pump house, Ash water recirculation pump house, vacuum pump house, decantation well, Silo Utility Building, Ash Handling Electrical Control Room, Ash Water Clarifier, HCSD Pump House. ash pipe supports including culverts, coarse ash tank, ash water sump bridges etc. upto the existing Ash Dyke, extension of existing ash dyke and construction of HCSD ash dyke as shown in Plot Plan attached with this specification. Modification (if required) of existing return channel and decantation well is also in the scope of this package.

Works shall include bottom ash hopper supports, dry extractor / cooler supports & foundation, pre-crusher / primary crusher supports, vibrating feeder supports & foundation, conveyor trestle supports & foundation, bottom ash pipe supports, bottom ash extraction equipment supports, ash slurry pipe supports from ash slurry pump house, dry fly ash & bottom ash pipe supports, supporting structure for buffer hopper, buffer hoppers, fly ash silos, development of silo area (including paving, fencing, access roads, office block and watchman cabin), pump and equipment foundations, ash compressor house, MCC room, RCC thrust blocks, electronic weigh bridge and other buildings, supporting structure facilities required to complete the system.

Structural arrangement, pile foundation system, if required, cladding interior and exterior finishes, area paving etc., shall be as per total plant building design and finish schedule furnished elsewhere in the specification.

Pipelines shall be supported on steel structures supported on RCC pedestals and pile foundations, if required. The top level of the pipe pedestals shall be 300mm above the formation level. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements. For crossing of the pipe lines and maintenance road with nallahs, canals etc. and / or for road / rail crossings, pipes shall be laid through RCC box culverts / bridges. Road leading to silos shall have minimum width of 7.5m with both sides berms 1m and drains.

The compressors and their associated equipments shall be housed in RCC building along with requisite MCC room. Crane / monorail of adequate capacity shall also be provided in all pump / compressor house.

All buildings in Ash Handling Plant shall be of RCC construction with RCC columns, beams and slabs and brick cladding around.

For RCC buildings of more than 15M span steel roof truss/girders (supported on RCC columns) will be provided to support the concrete roof on permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile supported on steel purlins which are spanning between two adjacent roof trusses. The thickness of sheet shall as per the design requirement considering worst load combination subject to a minimum thickness of 0.8mm. Gable and side cladding will be constructed with brick masonry. Metal decking sheet for roof shall consist of permanently colour

coated galvanized M.S. sheet and silicon modified polyester paint shall be used for permanent coating on exposed surface. The galvanization shall be 275gm/sqm and DFT of permanent colour coating shall be 20 micron (approx). Primer coat shall be provided on inner side.

Necessary monorails/hoists/cranes shall be provided as per requirements described elsewhere in this specification.

RCC slab-on-grade on ground floor shall rest on 230 thk. Boulder soling laid over well-compacted earth-fill with approved quality earth. Ground floor slab will have drainage trenches covered with steel grating.

Stairs and platforms shall be provided as required for maximum utility and safety. Stairs shall have to be provided as per TAC regulations and any other statutory requirements.

15.2 Following facilities shall be provided near the silo as per Vol. III of specification.

- i) Ash slurry sump with pump house.
- ii) Ash water sump house with pump house.
- iii) Complete Ash Water recirculation systems.
- iv) MCC Room / Control room.
- v) Other buildings as per system design requirement as described in relevant sections/volumes of this specification
- vi) Pipe Rack / trenches etc. in the plant area.
- vii) RCC paving in Silo area
- viii) Office block of minimum 50 sqm and Watchman cabin of minimum 5 sqm area shall be provided.
- ix) Dry ash storage silo area shall have compound wall all around with gate. 2100mm high compound wall with 600mm high fencing at top shall be provided.
- x) The following densities shall be considered for design of silos:

(a) For volume calculation of bottom ash silo	:	650 kg/cum
(b) For volume calculation of fly ash silo	:	750 kg/cum
(c) For load calculation of both types of silos	:	1600 kg/cum
- xi) The concrete ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top $1/3^{rd}$ portion and by a factor of 1.75 for the bottom $2/3^{rd}$ portion. Special attention shall be given in assessing the effect of hot temperature of ash on the concrete wall. Temperature of ash shall be taken as 150°C.

Storage capacity of silos shall be as mentioned elsewhere in this specification. Minimum thickness of silo shell shall be 250mm. Silos should be designed for worst combinations of loads as per requirements of relevant Indian Standard codes. Silos shall be interconnected with intermediate platforms at different levels including roofs. Access to different floors and roofs shall be provided through steel stairs.

15.3 Ash Pipe Supporting Structure

Ash pipe from plant area to Ash Dyke will be supported either on existing pedestal or new pedestals. Modification and strengthening of existing pedestals (wherever required) is in the scope of Bidder. New pedestal to support ash pipe shall be constructed by the Bidder.

Suitable arrangement including constructions of bridges/ culverts to cross the existing roads / drains in entire route of ash pipe is also in the scope of Bidder. Modification / strengthening of existing culverts in ash pipe route will be done by Bidder. Bidder has to perform all the activities complete in all respects including labour, material or any other requirements to the satisfaction of Engineer. Total route length of ash pipes is approximate 6 km.

All clearances/permissions will be arranged by Owner.

Removal of defunct pipe lines, if any, shall be in the scope of Bidder.

Necessary modification / widening / strengthening of existing culverts in entire route of ash pipes is in scope of Bidder.

16.0 RAW WATER PRE-TREATMENT, DM PLANT SYSTEM, EFFLUENT TREATMENT SYSTEM AND SEWAGE TREATMENT SYSTEM

16.1 Raw water pre-treatment plant, DM Plant, ETP & STP will generally consist of the facilities / buildings already mentioned in Chapter 2 of this Volume. However, the bidder may add / delete / club facilities as per approved system.

The stilling chamber, flash mixer and cascade aerator shall be of RCC structure. The chambers and water channels shall be watertight structures.

The clarifier shall be of RCC construction. The watertight circular RCC structures shall have continuous platform with handrail along periphery at the top. At least 3 nos. ladder shall be provided at the outside and vertical rungs shall be provided inside for maintenance.

The sludge sump (reject sump) shall be an underground RCC pit, part of the pit shall be cover with RCC slab for supporting the vertical sludge pumps. The sludge pumps shall be housed in a pump house with RCC roof supported on RCC columns and beams. There will be hoist and monorail of required capacity for handling of pumps. Capacity of reject sump is indicated in Vol. III & Composite Water Scheme.

Clarified water reservoir shall be of water tight RCC construction having two compartments covered with RCC roof. Vent pipes shall be provided at roof. Clarified water reservoir including RCC roof shall be designed as uncracked structure as per IS:3370. The clarified water pump house structure shall be of RCC / steel framed construction with RCC flat roof. Side cladding shall be of brick masonry/ colour coated metal sheeting. Monorail or gantry shall be provided for handling pumps. The building shall be complete with doors, windows and rolling shutter. Floor and other finishes shall comply with architectural specification. Capacity of the clarified water reservoir is indicated in Vol. III & Composite Water Scheme.

Thickener shall be of RCC construction designed as uncracked section.

Pretreatment chemical house shall be a two storied concrete RCC framed building. Clear height of 5.5m (minimum) shall be provided in each floor. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring, plaster, painting, roofing etc. and all other items necessary for satisfactory performance of the building. The building shall have toilets and the scope shall include supply and fixing W.C.'s urinals, showers and all plumbing sanitary and other work required for satisfactory completion of the above building. The tanks and parts of floor slabs shall be lined with acid / alkali proof tile lining. Monorails of adequate capacities shall be provided as per functional requirements. The building shall be provided with adequate toilet facilities.

Near the chemical house there will be a single storeyed RCC framed building housing the chlorination plant. Hoists with monorail shall be provided for normal plant operation and for handling of equipment during erection / maintenance. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring and painting, roofing etc. and all

other items necessary for safety and satisfactory performance of the building. Brick masonry wall with suitable windows and doors will be provided in accordance with architectural specification.

The DM plant building will be RCC framed building having brickwork cladding on all four sides. Ground floor shall house MCC and control room. Control Room which shall have false ceiling and shall be air-conditioned. Central chemical laboratory and office rooms etc. shall be at first floor level, which will also have false ceiling and air condition provision. Equipment foundations & trenches in ground floor slab shall be of reinforced cement concrete. Ground floor shall have ironite flooring except at locations, which may come in contact with acid/ alkali where acid / alkali resistant tile lining with epoxy mortar shall be provided. Effluent drain trenches shall also have acid proof lining at inside surfaces of drain as well as soffit of pre-cast removable covers. The building shall be provided with adequate toilet facilities.

Floor where acid / alkali spillage are expected shall be isolated with RCC kerb. Neutralizing pit shall be of watertight RCC construction. Internal surfaces shall be lined with acid / alkali proof lining with matching epoxy mortar. Neutralization pit shall be designed as uncracked section. Ceiling as well as floor, supporting pumps shall be given epoxy lining.

Acid / alkali storage tanks shall be resting on RCC saddles on elevated RCC platform. The platform shall be supported on RCC beams, columns with RCC foundations. The saddles along with platforms shall be lined with acid/alkali proof tiles.

Acid / alkali storage and handling area shall also be lined with acid / alkali resistant tiles.

The DM storage tanks shall rest on thoroughly compacted fill of gravel, coarse sand or other stable material topped with minimum 75 mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. This filling shall be confined within a RCC ring wall with foundation. The tank shall have complete bearing with the foundation fill. Where soil is very poor, tank may have to be founded on concrete pad resting on piles or the bearing capacity will be improved using ground improvement technique. All backfilling within tank foundation shall be done by compacted sand. Degasser shall be supported on RCC framed structure. Minimum 2.5m wide RCC pavements shall be provided around each outdoor equipment.

All water/effluent retaining structures in Effluent Treatment and Sewage Treatment Plants shall be of RCC construction and designed as water-tight as per IS:3370.

17.0 ARCHITECTURE**17.1 Architectural Concepts**

- a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation & wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.
- b) Main Plant Building 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 comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.
- c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.
- d) Overall colour scheme and finish schedule of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its façade, equipments, exposed structural elements, piping, trestles, bus ducts and other service elements.
- e) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipments so that the proper coordination with other agencies can be taken up at appropriate time.

17.2 Architectural Design

- i) Natural light shall be used to the maximum extent specially in the form of north light / sky light. For adequate light & ventilation, National Building code recommendations shall be followed.
- ii) Entrance canopies, chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- iii) All the buildings shall be architecturally designed to meet the National Building Code (SP:7) norms and local building bye laws, wherever applicable.

- iv) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of National / International repute having experience in similar kind of works. The consultant shall evolve the design philosophy based on Employer's guidelines and shall present it in the form of presentation drawings, Prospective views, 3-D Models & detail drawings.
- v) Minimum 1000mm high (from floor / roof level) hand railing shall be provided around all floor / roof openings, projections / balconies, walkways, platforms, steel stairs, etc., All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736 treated with primer and finished with suitable paint. All rungs and ladders shall also be galvanized. Minimum weight of galvanizing shall be 610 g/sqm.

All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.
- vi) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 250mm. Minimum clear width of stair shall be 1200mm unless specified otherwise.
- vii) All buildings having metal cladding shall be provided with a 150mm high RCC toe curb at the edge of the floor along the metal cladding. 900mm high hand railing shall be provided on this RCC curb, wherever required from the safety point of view.
- viii) In all buildings, structures, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or pre-cast RCC panels.
- ix) RCC staircase shall be provided for all RCC construction buildings and structural steel staircase for all structural steel buildings.
- x) Parapet, Chajjas over window and door heads, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.
- xi) All fire exits shall be painted with 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 firefighting equipment. In detailing of all buildings, fire safety requirements conforming to IS:1641 and IS:1642 shall be followed.

17.3 Interior Design

A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



environment. It shall take into account the multidisciplinary engineering activities involving power plant technology, and architectural and civil engineering for a smooth control hierarchy and man machine inter face. All the design aspects such as flooring, false ceiling, furniture, colour scheme, equipment design and 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 main-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 drawing etc.

17.4 Roof Drainage and Water Proofing

- a) Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rain water down corners and fixtures. System shall be designed to handle design rainfall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. The down corner pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.
- b) Multiple drains (minimum 2) shall be provided for all roof areas. Any roof more than 8 m above grade shall have access from within the building for cleaning of roof drains.
- c) Rain water down comers shall be of M.S pipe conforming to IS: 1239.
- d) All roofs shall be provided with water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5mm. The treatment includes application of polymerized mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40mm screed of 1:2:4 concrete as above cast in panels of 1.2m x 1.2m and reinforced with 0.56mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered tiles as above.

17.5 Master Key System

An appropriate serviceable and functional master key system for the whole plant shall be installed. The elaboration of the system itself shall be made in close co-ordination with the Purchaser / Consultant and only after obtaining the Purchaser's / Consultant's approval in writing shall the order of production be placed.

The following requirements shall be met:

- The general master key shall operate all locks
- The main key shall open all locks of one building
- The single key shall open the lock of a single room.

Necessary attention shall be paid to later extensions of the master key system, which shall be suitable for the entire plant including all final stages.

The keys shall be made of material approved by the Purchaser / Consultant and shall have an engraved indication of the applicable key system and the building or door number.

Keys shall be supplied in the following numbers:

General Master Key	10	nos
Main keys	10	nos. per each building
Single keys	3	nos. per each door

17.6 Land Scaping

17.6.1 General

This specification covers broadly the requirements for Landscaping within the Plant Area. Landscaping shall be carried out after all the underground utilities and drainage systems are in place. The entire work of Landscaping shall be carried out to the satisfaction of the Engineer / Consultant and in a manner to have a beautiful appearance after completion of the work.

The Landscaping plan should be prepared by the Contractor with the help of an expert Horticulturist with due considerations for Fauna & Flora grown in the adjacent area and which can sustain in the saline climate.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer and the work shall be divided into following sub-items.

17.6.2 Preparing Lawn

For this purpose, within the area where lawn is to be grown, about 0.3 metres of earth shall be removed. This shall be replaced by fresh garden soil and manure in 2:1 proportions spread evenly. Fresh garden soil & manure shall be mixed thoroughly, well watered and left overnight. The next morning, the variety of lawn, as per approved plan and as directed by the Engineer, shall be planted. This grass shall be maintained till well established by watering, weeding, clipping, rolling etc.

17.6.3 Preparing Clipped Hedges

Hedges made of Casuarinas or other shrubs as directed by the Engineer shall form borders between footpath and the Lawns. The shrubs shall be planted at spacing not more than 25 cms.

17.6.4 Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bougainvillea, Hibiscus etc. which are perennial shall be planted in clusters or over a large area at locations and in the manner as per approved layout. These shrubs shall be planted at spacing of not more than 25 cms.

17.6.4.1 Planting Trees

Trees of different category and height shall be planted as per prior approval from Owner.

17.6.5 Installation of Watering System

Contractor shall prepare and submit watering System for the Plants. Drip Irrigation and Spray System consisting of complete PVC pipe with all necessary bends, Tees, Elbows etc., valves, stop cocks, Spray nozzles, sufficient lengths of Flexible PVC pipes to reach all area of Landscaping shall be included in the watering system. Only after approval of the Engineer, the Contractor shall commence the work.

17.7 Architectural Finishes**17.7.1 Plastering**

- a.) The plastering work including the application of cement punning (Neru) or plaster of Paris treatment on brick or concrete faces with architectural features shall be executed as per in accordance with the following latest IS codes: POP shall be used only on inside surfaces of ceiling and walls for aesthetic and architectural requirement.

IS:1542	: Sand for plastering
IS:1661	: Code of practice for application of cement and cement lime plaster finishes.
IS:2333	: Plaster of Paris
IS:2402	: Code of practice for external rendered finishes
IS:2394	: Code of practice for application of lime plaster finishes.

- b.) Mortar for plastering shall be mixed in the proportion in a dry state and then wetted and mixed thoroughly to obtain the required consistency. The mortar shall be mixed in an approved manner including machine mixing in batches for its consumption within half an hour of mixing. Any mortar for partially set plaster shall be rejected and removed from site. The mix for plastering shall be as follows:
- i) Outside plaster on masonry wall: no plastering is required on outside of masonry wall. Since outside surface of brick wall will be exposed, contractor to manufacture good shape bricks to suit the exposed brick work. Silicone coating shall be provided on outside exposed face of brick wall.

- ii) Inside plaster on masonry wall: 12 mm thick (1 cement : 3 sand)
- iii) Concrete ceiling: Plaster : 6 mm thick (1 cement : 3 sand)
- c.) Before application of plaster, the surface shall be prepared as per IS:1661. In all plaster work, mortar shall be applied in an uniform layer slightly more than the required thickness and well pressed into the joint and in the surface and rubbed & levelled with a flat wooden rule to give required thickness.

Plaster, when more than 15 mm thick, shall be applied in two coats, base coat followed by the finishing coat. Thickness of base coat shall be just sufficient to fillup all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The under-coat shall be thicker than the upper coat. The overall thickness of the plaster 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". The finished surface shall be true to line & plumb; and the contractor shall make up any irregularity in the masonry/concrete work with plaster. The mortar shall adhere to the surface intimately when set; and there should be no hollow sound when struck.

All vertical edges of pillars, door jambs etc. shall be chamfered or rounded off. All corners must be finished to their true angles or rounded. Any plastering damaged shall be repaired and left in good condition at the completion of the job.

- d.) All plastered surfaces after laying and sufficiently hardened shall be cured for a minimum period of seven days and shall be protected from excessive heat and sunlight by suitable approved means.
- e.) Plaster of Paris Finish: The plaster of Paris shall be calcium sulphate hemi-hydrate variety. Its initial setting shall be less than 13 minutes. The material shall be mixed with water to workable consistency. Plaster of Paris shall be applied to the surface in the uniform layer slightly more than 2 mm thick and shall be finished to an even and smooth surface with a steel trowel. Thickness of finish shall not be less than 2 mm. All corners, arises, angle and junctions shall be carefully and neatly finished.

17.7.2 Wall Cladding

Permanent colour coated sandwiched insulated metal cladding system

- a.) Permanent colour coated sandwiched (insulated) M.S. / High tensile steel metal cladding of approved colour combination shall be provided for main plant building and any other building with metal cladding where thermal insulation is required as per thermal requirements.

- b.) Troughed zinc-aluminum alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150mm /sq.m. The outer side ((exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.
- c.) Galvanised M.S. sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 180 gm/sq.m.
- d.) The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.
- e.) Inner sheet shall fixed directly to side runner and Z spacers made of at least 2 mm thick galvanized sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50m centre top centre to hold the insulation and external sheeting.

17.7.3 Permanent colour coated non-insulated metal cladding system

- a.) Permanent colour coated (non-insulated) M.S / High tensile steel metal cladding of approved colour combination shall be provided for bunker building and cladding over parapet walls of buildings where metal cladding is specified.
- b.) Troughed zinc-aluminum alloy coated not less than 150 gm/sqm M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used for cladding system. The outer side (exposed face) shall be permanently colour coated with with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanization. The minimum thickness of roof sheeting shall be 0.8mm with galvanization rate of 275 gm/sqm.

17.7.4 Roof Decking And Suspended Ceiling

- a.) The roof decking includes furnishing of cold rolled formed troughed profile sheets manufactured from tested quality CR rolls conforming to IS:513 including fixing. The profile sheet section shall be obtained from feeding strips of uniform coil thickness through successive pairs of shaped rollers, each pair of rollers progressively forming the sheet until finished section is obtained

In general the troughed profile shall have minimum depth of valley 44mm and center to center of valley about 130mm. The thickness of sheet shall be 0.8 mm (minimum). To suit the spacing of purlin, the length of sheet may vary between 1.50 to 2.00 m. The overall minimum width of sheet shall be 824.20mm and covering width as 780mm i.e. side overlap shall be 22.10 mm.

- b.) **Pre-Treatment & Phosphating:** The pre-treatment process shall conform to medium class-B conforming to IS:3618. Next operation of rust removal shall be done by dipping in a tank containing highly diluted hydrochloric acid (HCL); and traces of HCL shall be removed by double rinsing in a water tank for about 5 minutes each. Subsequently sufficient conditioning shall be done by dipping in the next tank containing surface conditioner. Hot phosphating shall be accomplished in the next tank followed by water rinsing and finally passivated by heat process in the passivation tank. Thereafter traces of moisture shall be removed by hot compressed air before application of primer and final paint coating as required. In general the pre- treatment stages shall be as under:

Sl. No.	Stages	Chemicals	Processing Temp.	Processing Time
1.	Degreasing	Cleaner	55 to 75° C	3 to 10 minutes
2.	Water Rinsing	-	Room Temp	-
3.	Derusting	Rust remover	R. Temp to 60°C	1 to 10 Mts
4.	Water Rinsing	-	Room Temp	-
5.	Surface conditioning	Surface conditioner	Room Temp	15to 30 sec.
6.	Phosphating Solution	Phosphating	50 to 55° C	3 to 5 Minutes
7.	Water Rinsing	-	Room Temp	-
8.	Passivation Solution	Passivation	Room Temp.	15 to 30 sec
9.	Water Rinsing	-	Room Temp	-
10.	Defonised water	-	Room Temp	-
11.	Drying			
After pre-treatment, the sheet shall be painted with a coat of zinc chromate red oxide primer on both faces.				

17.7.5 Flooring

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete 1:2:4 with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.

a) False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab shall be sunk to a

depth 800 mm which shall be height of the false floor system. The flooring shall consist of fire resistant phenol formaldehyde bonded particle board panels 600x600x35mm size, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. 2 mm thick flexible anti-static pvc topping on top and pvc strip edging on sides of each panel shall be provided.

b) PVC Floor Finish

Two mm thick PVC as per IS:3462 laid as per IS:5318 over concrete under bed of 48 mm .

c) Carborandum Tiles

Polished heavy duty cement concrete tiles (carborandum) of 300x300x22 mm thick manufactured as per IS:1237 using colouring pigment and hard chips like carborandum, quartz etc shall be laid as per IS:1443 over concrete under bed to result in overall thickness of 50 mm.

d) Terrazzo Tiles

Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

e) Granolithic flooring

- i. Granolithic flooring (cement concrete flooring in 1:1:2) with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunker bay, Workshop floors, operating floor of pump house, permanent stores and other plant building areas where heavy duty flooring is required.
- ii. Granolithic flooring without floor hardener shall be provided in all MCC and switch gear rooms which are not air-conditioned.
- iii. Granolithic flooring shall also be provided in areas which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.

f) Ceramic Tiles

Heavy duty anti skid ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x 10 mm of approved colour / shade and brand. Dado in toilets and pantry, locker rooms etc shall also be of similar finish

g) Acid / Alkali resisting Tiles

Battery rooms, and other areas coming into contact with acid / alkali vapors or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS:4832 (Part-I)

and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS:4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.

h) **Integral floor finish**

For cable vaults room, floors of wagon tripler shed, reclaim hopper shed, crusher house, junction towers, pent house shall be provided with floor finish integral to the concrete base shall be provided as per IS:2571.

i) **Cast-in-situ Terrazzo**

Cast in situ terrazzo flooring shall be laid as per IS:2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.

j) **Glazed vitrified tiles**

Polished vitrified tiles shall be of 600 mm x 600 mm x 10 mm in size and shall be approved shade, brand and colour and shall be laid with CM 1:3. These are proposed in the following areas:

Operating floor, Control room area including control room, computer room, control equipment room, SWAS Room and Conference room, senior executive room – The floor shall have vitrified tiles of size 2 feet X 2 feet applicable for industrial use.

17.7.6 Acid / Alkali resistant Tiling / Brick lining in D.M Plant

- a Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS:4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, curbs andsumps, all as per the acid / alkali proofing specialist Contractor's requirement.
- b For floor of neutralizing pit the finish shall be as follows. Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.
- c For walls of neutralizing pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.
- d Special instruction to be followed for acid resistant lining in neutralizing pit shall be as follows.
 - i) The structures shall be tested for water tightness.
 - ii) Surface on which lining is to be applied shall be prepared as per IS:2395.

- iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.
- iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.
- v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.
- vi) Acid / alkali resistant treatment shall extend at least 1 meter on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 meters all round for outdoor installations.

17.7.7 Skirting / Dado

- a 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.
- b Toilets & locker rooms shall be provided with dado of 2100 mm high .
- c For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.
- d For battery room and other areas coming in contact with acid / alkali spillage/ fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.
- e Staircase wall shall be given dado of cast in situ terrazzo to a height of 2100mm. If Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.

17.7.8 Doors, Windows, Ventilators, Louvers Etc.

Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodized) aluminum framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.

Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors / glazed panels of aluminum frame work with toughened safety double glass glazing confirming to IS 2553 hermitically sealed and separated by 12 mm thick cup for thermal insulation. Doors shall be of double swing type or sliding type.

For common control building, double glazed wall panels with aluminum frame shall be provided between air-conditioned and non air- conditioned areas and

on the side of control room and control equipment room(s) facing the operating floor to have a clear view.

Single glazed panels with aluminum frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

Coal conveyor galleries shall have steel windows/ventilators shall be as per IS1038

All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G 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 18 G. 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, etc.

Steel windows and ventilators for coal conveyor gallery shall be as per IS:1361 and for all other areas as per IS:1038. Windows of coal galleries shall be provided with wire mesh.

Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.

All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodized aluminum grill.

Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.

Hollow extruded section of minimum 3 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminum doors, windows and ventilators.

All door sizes shall be decided carefully, keeping in view the size of the machinery/panels to be erected inside the building. In any case opening height shall not be less than maximum height of machinery/panel installed inside the building.

IS Codes

Following are some of the important IS codes (latest edition) applicable to this section:

IS:204 (Part-II) :	Tower bolts non ferrous metals
IS:208 :	Door handles
IS:2002 (Part-I) :	Flywood face panels
IS:1341 :	Steel butt hinges
IS:1868 :	Anodic coatings on aluminum and its alloys
IS:3564 :	Door closers (hydraulically regulated)

IS:5187	:	Flush bolts
IS:6315	:	Floor springs (hydraulically regulated) for heavy doors
IS:7195	:	Hold fast
IS:7452	:	Hot rolled steel sections for doors, windows and ventilators
IS:10019	:	Mild steel stays and fasteners
IS:1038	:	Steel doors, windows and ventilators
IS:1361	:	Steel windows for industrial ventilators
IS:1948	:	Aluminum doors, windows and ventilators
IS:1949	:	Aluminum windows for industrial buildings
IS:4351	:	Steel door frames
IS:3614 (Part-I)	:	Fire check doors
IS:10451	:	Steel sliding shutters (top hung type)
IS:4021	:	Timber door, window and ventilator frames
IS:1003 (Part-I)	:	Timber paneled and glazed shutters – door shutters.

17.7.9 **Wall paneling**

All the exposed structural steel i.e. wall, columns, bracings in STG control room and air-conditioning areas shall be provided with wooden wall paneling. The wall panel shall consist of teak wood batten grid of size 600x600 mm or as per site requirement. The size of batten shall be 2 inch x 1 inch. BWP grade plywood conforming to IS:710 shall be fixed on this grid. The Vanner of approved quality and shade shall be fixed on the plywood as exterior finish with suitable adhesive. The entire work shall be carried out to the satisfaction of engineer.

17.7.10 **Glass and Glazing**

All ventilators and windows on external face of turbine building, conveyor gallery, pump house, compressor house, DG set building, transfer points, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.

Glazing in control room between AC and Non AC areas shall be double glazing consisting of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.

For single glazed aluminum partitions and doors, Float glass or flat transparent sheet glass of minimum 6 mm thickness shall be used.

Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.

Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.

Float glass or flat transparent sheet glass shall conform to IS:2835. All glazing work shall conform to IS:1083 and IS:3548

17.7.11 **False Ceiling and Under Deck Insulation**



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



All air conditioned areas shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room shall also be provided with under deck insulation.

Aluminum false ceiling system shall comprise of 84 mm wide 12.5 mm deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminum alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.

Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.

CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.

Under deck insulation shall comprise of 50 thick PUF material of density 36 kg/cubic meter . This mat shall be backed with 0.05 mm thick aluminum foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.

17.7.12 Painting

Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to enhance overall appearance will be permitted if such finish meet with the technical requirements.

Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.

Inside surfaces shall be provided with Acrylic washable distemper for all areas as per IS:428 except for Control room, Control equipment rooms, all air conditioned areas for which Acrylic emulsion paint shall be provided as per IS:5411.

Inside surfaces shall be provided with Acrylic distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.

Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.

All plastered ceilings shall be provided with acrylic washable white distemper as per IS:42.

Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.

All wood work shall be provided with fire resistant transparent paint as per IS : 162 over french polish as per IS:348 or flat oil paint as per IS : 137.

Painting for structural steel have been specified else where in this document. Following general instruction for painting shall be followed.

- i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
- ii) For painting on wood work IS:2338 part I & II shall be followed.
- iii) All paints shall be of brand and make to the approval of OWNER.
- iv) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.
- v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
- vii) Thinner shall not be used with textured paint (sandtex matt etc) finish.
- viii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.

17.7.13 Chemical Resistant Treatment Battery Room

- a.) Battery room floors and other surfaces as required shall be provided with acid/alkali resistant tiles and treated suitably as detailed below by supplying & furnishing of all labour, materials & equipment in accordance with the following latest codes:

IS : 3384 : Specification for bitumen primer for use in water proofing & damp proofing

IS:4443 : Code of practice for use of resin type chemical resistant mortars

IS:4457 : Specification for ceramic unglazed vitreous acid resistant tiles.

IS:4832 : Specification for chemical resistant mortars (Part I to III).

IS:4971 : Recommendation for selection of Industrial floor finishes.

- b.) The surfaces to be treated against acid shall be levelled smooth, dry & clean. The entire surface shall be tapped by wooden hammer to determine hollows if any. In case hollows are found, they shall be suitably sealed with concrete or other approved materials.

- c.) The unsatisfactory surfaces shall be replaced by new concrete or other suitable material after ensuring proper bond between the new and old surface. Surface to be prepared shall be wetted for 24 hours; use of epoxy resins for bonding fresh concrete during repairs shall be permitted with Engineer's subject to its execution as per Manufacturer's instructions. All patched areas shall be properly cured by sprinkling water for a period of not less than 10 days.

17.7.14 Acid / Alkali Resistant Tiles on Floors & Walls

- a.) The surface after preparation shall be applied with a coat of bitumen primer conforming to IS:3384 (latest). The primed surface shall be subsequently applied with a uniform coat of bitumen conforming to IS:1580.
- b.) For bedding of tiles, potassium silicate based cement mortar [15 mm thick] as per IS:4832 shall be used spreading on the back & two adjacent sides of the tile. The tile shall be pressed on the floor or wall & push against floor or wall until the joint in each case of 6 mm thick & 6 mm width is maintained with spacers. Before the bedding mortar sets completely, the jointing material shall be removed to a depth of 20 mm. After the bedding mortar is properly set, the joints shall be cured with resin type mortar filling up the entire length of the joint. The excess mortar shall be trimmed off to make the joints smooth & place. Seal coat shall then be applied over the epoxy mortar to cover up porosity that may be left in mortar. Acid resistant tiles shall be provided for a height of at least upto lintel level on all the walls of battery room. The rest of the battery room walls & ceiling shall be provided with 2 coats chlorinated rubber paint. The tiles used for flooring & walls shall be 20 mm thick conforming to IS 4457. Tiles of approved quality and shade shall be used.

Acid curing shall be carried out as per manufacturer's directions using the safety precautions normally used when handling acids. The mortar joints shall be cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid no sooner than 2 days and not later than 6 days after the masonry units are bonded with the mortar. The curing time shall be at least 60 minutes.

Performance guarantee: The contractor shall be responsible for the safety, suitability & efficient functioning of all the acid resistant treatment. He should guarantee for efficient performance of the treatment for a period of five years time from the date of the completion. During the guarantee period, if at any stage, it is found that any of such treatments has given way or has not been functioning satisfactorily, the same shall be made good by the contractor at his own cost.

17.7.15 Finishing Schedule



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



The minimum quality of finishes used for various building areas are furnished in Table-1 in this section. The Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified in this specification.

TABLE 1 : FINISHING SCHEDULE

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
STG Building					
Ground Floor: Maintenance Bay & Unloading Areas	Acrylic washable distemper	Granolithic with non-metallic hardner	Acrylic distemper	--	Water proof cement based paint
Ground floor general area	Acrylic washable distemper	Granolithic Flooring	Acrylic distemper	--	
Cable Room	Acrylic distemper	Granolithic with non-metallic floor hardener	Acrylic Distemper	--	
Electrical Room	Acrylic distemper	Granolithic with non-metallic floor hardener	Acrylic Distemper		
Mezzanine Floor	Acrylic washable distemper	Granolithic flooring	Acrylic Distemper	--	
Operating Floor Operating Area, laydown area	Acrylic washer distemper	Polished Kota Stone	Acrylic Distemper	--	
Central Control Room	Acrylic emulsion paint	Glazed Vitrified tiles Double Charge	Aluminum False Ceiling		
Electronic cubicle room & Computer room	Acrylic emulsion paint	Heavy duty ceramic tiles	Aluminum False Ceiling	--	
Conference room, senior executive room	Acrylic emulsion paint	Glazed Vitrified tiles Double Charge	Aluminum False Ceiling	--	
Switchgear room	Acrylic washable distemper	Granolithic with non-metallic floor hardener	Acrylic Distemper	--	
Battery Room	Acid & alkali tile dado for 2100 mm high + Chlorinated rubber based paint	Acid / alkali resistant tiles	Acid Resistant Paint	--	
SWAS room	Acrylic washable distemper	Glazed Vitrified tiles Double Charge	Acrylic Distemper	--	--

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
General circulation and movement areas	Acrylic washable distemper	Polished Kota Stone	Acrylic Distemper	--	
Heater area	Acrylic washable distemper	Heavy duty cement concrete tiles (Carborandum)	Acrylic Distemper	--	
Office Area	Acrylic emulsion paint	Glazed Vitrified tiles Double Charge	Acrylic Distemper	--	
Pantry	Dado for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic Distemper	--	--
Toilet	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic Distemper	--	
Roof	--	--	--	Elastomeric water proofing treatment	--
Other Buildings					
Bunker Building	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Cooling Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Raw Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Filter Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Chemical House	Acid/Alkali resistant tiles on wall up to 1500mm height & chemical resistant paint above.	Acid/Alkali resistant Tiles	Chemical resistant paint	Elastomeric water proofing treatment	Water proof cement based paint
DM Plant	Chlorinated rubber based paint	Acid/Alkali Resistant Tiles	Chlorinated rubber based paint	Elastomeric water proofing	Water proof cement based paint

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment treatment	Wall (External)
Chlorination Building	Acid / Alkali resistant tiles	Acid / Alkali resistant tiles	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
CPU Regeneration Building	Acrylic washable distemper	Granolithic Flooring	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Control Rooms	Acrylic emulsion paint	Glazed Vitrified tiles Double Charge	Aluminum False Ceiling	--	Water proof cement based paint
MCC Switchgear Room	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	--	Water proof cement based paint
Cable Vaults	Acrylic Distemper	Granolithic floor with non metallic floor hardener	Acrylic Distemper	--	Water proof cement based paint
Workshop	Acrylic washable Distemper in workshop area and Acrylic emulsion paint in office area	Granolithic floor with non metallic floor hardener in workshop area and Vitrified Tiles in office area	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Canteen : General Area	Dado for 2100mm high & Acrylic Distemper above.	Heavy Duty Ceramic Tiles	Acrylic Distemper	Elastomeric water proofing treatment	Granular finish
Kitchen	Dado for 2100mm high & Acrylic Distemper above.	Heavy Duty Ceramic Tiles	Acrylic Distemper		
Fire Station Building	Acrylic washable distemper	Glazed Vitrified tiles Double Charge in office, dormitory area & granolithic flooring with non metallic floor hardener in parking & equipment store area.	Acrylic Distemper	Elastomeric water proofing treatment	Water proof cement based paint
Service	Acrylic	20 mm thick	Aluminum	Elastomeric	Granular

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
building: Ent. Lobby, Reception, Portico & Lift Area Office Area	emulsion paint Acrylic emulsion paint	polished granite stone Glazed Vitrified tiles Double Charge	False Ceiling Aluminum False Ceiling	water proofing treatment	finish (Vineratex)

18.0 PILING

18.1 The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures are detailed below conforming to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations : Part I Concrete Piles and IS:2911 Part : IV Load test on piles and to this Specification. The contractor shall be responsible for all aspects of the pile performance installed including demonstration of the adequacy of his design by testing. During detailed design the contractor shall submit the proposed firm to undertake piling work with details piling system, method of installation, summary of design basis, number, type and size of construction plant items to be employed for the work including crane, piling equipment, concreting equipment and proposal for installation & testing of trial piles and tests on work piles.

18.2 Prior to installation of trial piles, the contractor shall submit final details of the trial piling installation including specifications, detailed design calculations and construction drawings for the trial piling together with associated equipment to be provided for construction and testing of the same. Design report discussing the overall results of the tests on trial piles and concluding with and justifying the proposed definition of reference piles; specification, with fully detailed construction drawings, supporting calculations for the final design of the working piles, and the field control procedures the contractor intends to use to verify that pile installation satisfies the requirements of his design should also be submitted.

18.3 Design Criteria

The following shall be the design criteria for the working piles :

- a. Piles shall be designed in line with approved soil investigation report as single vertical piles acting under a design load as deemed fit.
- b. Driving formula (where relevant) may be adopted inter alia as a criteria for acceptance. But the minimum founding requirements shall be based on recognized methods of soil mechanics design, appropriate to the type of pile.
- c. The piles shall be designed for a minimum factor of safety of 2.5 against failure under the design load specified.
- d. Piles shall be designed for a limiting settlement of a single pile under vertical design load of 8 mm at the head.
- e. Piles shall be designed to resist a maximum force due to critical load combination in any direction applied to the head of the pile at cut-off level. For this design condition it shall be assumed that the pile head is effectively as a fixed-end by the pile-cap.

18.4 Tolerance

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable pins or markers. For a pile head cut-off, at or above ground level, the maximum permitted deviation of the pile head cut off

center from the center point, shown on the setting out drawing shall be 75 mm in any direction. For a pile head cut-off below ground level, an additional tolerance will be permitted as below on the assumption that the pile head would have been within tolerance if the cut-off had been at ground level. The maximum permitted deviation of the finished pile from the vertical is 1 in 75. Forcible corrections to concrete piles shall not be made.

- 18.5** The contractor shall carry out the work to minimize noise and disturbance. If during the execution of the work, damage is likely to be, caused to mains, services or adjacent structures, the contractor shall submit proposal for repair or avoidance of such damage. The contractor shall ensure that damage does not occur to completed piles.

18.6 Records

The contractor shall keep records as below of the installation of each pile and shall submit record to the Engineer.

Table 1.0

a)	Piles reference number (location)	*
b)	Piles cut off level	*
c)	Pile type	*
d)	Nominal cross-sectional dimensions or diameter	*
e)	Pile design capacity	*
f)	Standing groundwater level	*
g)	Date and time of driving, red riving or boring	*
h)	Date of concreting	*
i)	Ground level at commencement of installation of piles	*
j)	Working level	*
k)	Depth from working level to pile toe	*
l)	Toe level	*
m)	Depth from working level to pile head level	*
n)	Length of temporary / permanent casing	*
o)	Type weight, drop and mechanical condition of hammer	*
p)	Number of type of packings used and type and condition of	*
q)	Record of blows per 300 mm over complete drive	*
r)	Set of pile or pile tube in mm per 10 blows or number of	*
s)	Temporary compression of ground and pile from time of marked increase in driving resistance until pile reaches	*
t)	Length and details of reinforcement	*
u)	Grade and slump of Concrete mix and control test	*
v)	Volume of concrete installed in pile	*
w)	Method of placing concrete	*
x)	Number of blows to form bulb where appropriate	*
y)	Level of water or drilling fluid at commencement of placing concrete	*
z)	All information regarding obstructions delays and other interruptions to the sequence of work	*

18.7 Driven Cast-in-situ Concrete Piles

- a.) Installation of piles shall be carried out as per layout construction drawings in accordance with latest IS codes as below:
 - i.) IS:456-2000 : Code of practice for plain and Reinforced Concrete
 - ii.) IS:2911-Part I : Code of Practice for Design and Section-I Construction of pipe foundation
 - iii.) IS:2911-Part IV : Test load on piles
- b.) The sequence of installation of piles shall be to the approval of the Engineer.
- c.) The equipment and accessories required for the pile driving shall be standard type. The capacity of the pile frame shall be selected after considering the size and weight of the casing to be handled, the location of the work and the hardness of driving. The steel casing used for installing the piles shall be straight and shall have sufficient wall thickness and strength to prevent damage, distortion etc. Detachable shoes used with the temporary steel casing shall be fabricated steel or cast iron, double rimmed and of requisite strength, and of the standard sizes used with the respective steel casing. The shoe shall be co-axial with the steel casing. Casings distorted from true uniform shape whether caused by driving or earth and water pressure resulting in a reduction of the cross sectional area of the pile in excess of 10 percent shall not be used in the works. The nominal casing size shall be 500 mm diameter.
- d.) The pile shall be driven to a set proposed by the contractor. The final set values shall be repeated thrice before terminating the pile at that level. All relevant data with back up, computations pertaining to "set" shall be submitted before commencing piling work for Purchasers approval. Any sudden change in rate of penetration shall be brought to the notice of the Engineer.
- e.) **Control of Pile Driving**
 Protection of pile heads and selection of pile hammer shall be as per IS:2911 Part I. The pile shall be driven as accurately as possible to the vertical. Piles shall be installed with due consideration for the safety of adjacent structures by a method leaving their strength unimpaired and which develops and retains the required load bearing capacity. In the case of piles close to existing plant and structures, the Engineer may specify suitable precautions which may call for additional working hours for the rig. The equipment and methods for installing piles shall be such that the loss of energy is limited to a minimum. Should the deviation of the installed pile be greater than the specified tolerances, the Engineer may at his discretion order the installation of additional piles after checking the design load on the pile group of which the particular pile forms part. Care shall be taken not to damage the piles by over driving. Any sudden change in the rate of penetration shall be noted and informed to the Engineer. Jetting of Pile by means of water shall not be permitted.
- f.) After complete installation of the casing before concreting, the contractor shall inform the Engineer to inspect the casing for proper plumb location and other

conditions. Only after approval concreting should proceed. Level readings shall be taken on each pile after driving and again after all the piles in a group are driven. Piles which are found to have resin shall be driven to the original depth and set.

- g.) The main longitudinal reinforcing bars in piles shall be in one continuous length. In long piles, joints shall be permitted in main longitudinal bars but these shall be kept to a minimum. Joints in adjacent bars shall be staggered at least 1 meter part along the length of the pile. Joints in reinforcement shall be such that the full strength of the bar is effective across the joint.

Longitudinal reinforcement shall be provided for the full length of the pile extending above pile cut off level to provide adequate bond length into the pile cap. The minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of cross-sectional area of the pile on the basis of the nominal casing diameter. Longitudinal reinforcement shall be formed into a rigid cage to resist deformation during handling and installation by the use of links or helical reinforcement. The minimum diameter of links and helical reinforcement shall be 6 mm spaced at 150 mm and not more than 300 mm. The longitudinal reinforcement shall project 52 times its diameter; above the cut off level of the pile to ensure adequate bond length inside the pipe cap. Minimum 6 Nos. of longitudinal reinforcement shall be provided. Reinforcement provided in pile shall be symmetrical about any axis on the pile cross section. The diameter of longitudinal reinforcement shall not be less than 12 mm. Lap or splice joints shall be provided with sufficient link bars to resist eccentric forces. Minimum cover to main reinforcement in the pile shall be 75mm.

- h.) The method of placing and the workability of the concrete shall be such that continuous monolithic concrete shaft of the full cross-section is formed. Mechanical vibrators shall not be used to compact concrete. Concrete in piles shall be of design- mix with minimum grade M25 with minimum cement of 400 kg/cum water cement ratio within 0.45 to 0.55 using super plasticized Sikament 170 or equivalent. Generally the slump of the concrete shall be within the range 100 to 150 mm. The contractor shall ensure the minimum specified strength in accordance with IS:456, IS:10262 & SP. 23 shall be followed as guidance for mix design. Compaction of test cubes shall be done under same condition as followed for concreting of piles.
- i.) In soft clays or loose sands ,or where there is likelihood of danger to green concrete due to driving of adjacent piles, the designed reinforcement should be provided up to the full pile depth, regardless of whether or not it is required from uplift and lateral load considerations. Refer clause 5.11.2 of IS : 2911 (Part I / Sec-1)

j.) Cleaning out of casing

Before placement of concrete ,it shall be ensured that the inside of the casing is free from sludge or any foreign matter. The contractor shall ensure that water does not enter the casing tube/pile shoe at the end of driving & during the concreting operations. The existence of water inside casing tube after driving and before executing the concrete operation, if any shall be checked by the contractor by suitable probe & concreting of pile work shall be allowed to proceed if water level is less than 15 cm measured above the inner surface at the top of the shoe. If the water level is more than 15 cm, contractor shall take remedial measures viz. bailing or pumping to reduce the depth of water

before concreting & if it is not possible to do so then the contractor shall re-drive the casing at no extra cost to the Purchaser.

k.) **Concrete Level – finishing of pile head**

The cut-off level shall be as shown on the construction drawings. Concrete shall be cast to minimum of 500 mm above the cut-off level, or local ground water level, whichever is higher. Withdrawal of temporary casing shall be carried out in stages during the concrete placing operation with utmost care maintaining an adequate head of concrete above the bottom of casing at each stage of withdrawal so as to prevent the inflow of soil and water into the bore. Section of empty hole remaining above the head of the pile shall be temporarily backfilled with sand or other approved material prior to excavation for pile cap construction.

l.) **Trimming of pile heads**

Following excavation subsequently for pile cap construction, the contractor shall carefully remove excess concrete above specified cut-off level, without damaging the remainder of the pile including the projection reinforcement. Any cracked or defective concrete occurring below specified cut-off level shall be cut away and made good with new concrete properly bonded to the old. Piles that are defective shall be pulled out or left in place as judged by Engineer without affecting performance of adjacent piles. Also the contractor shall be bound to install additional piles to substitute the defective ones as per the directions of the Engineer.

m.) The dynamic cone penetration tests shall be carried out for a depth of at least 2 meters from the termination depth. The number of such tests shall be as follows :

- a. One number dynamic cone penetration test for each pile group consisting of more than four piles.
- b. For TG and Chimney pile groups the number of dynamic cone penetration tests shall be one per cent of the total number of piles.

18.8 Load Tests on Piles

- a) Load test shall be in accordance with IS:2911 Part IV (latest revision) Initial load tests on "Trial Piles" shall be executed in advance of works pile construction and shall comprise vertical load tests at locations as directed. Load test on trial piles shall also include lateral load test and uplift load tests as directed by the Engineer. 6 number of trial piles shall be tested from each capacity of the pile. Out of the six (6) nos. of piles to be tested for two (2) nos. each capacity shall be tested for vertical load, two (2) nos. for lateral load and two (2) nos. for uplift load.

Routine load tests on "Works Piles" shall be vertical load test and lateral load tests on piles as directed by the Engineer. Number of routine tests to be conducted on work piles shall be equal to one and half (1.5) percent of the total number of piles used in the work for vertical load tests as well as lateral load tests.

- b) Load tests shall not normally be undertaken by the contractor within 28 days after the installation of the piles in position. However, the contractor may be allowed by the Engineer to use rapid hardening cement or add necessary admixtures to enable him to conduct the tests within a lesser period. Before any load test is done, the proposed arrangement for carrying out the load tests including the preparation of the structure to receive the loads and the type of loading to be adopted shall be furnished by the contractor.

c) **Vertical Load Test on Trial Piles**

Load tests to verify the contractor's design shall be carried out on piles of different capacities proposed to be used. The contractor shall commence testing as early as possible after installing the piles. The test shall be carried out by applying series of loads on RC cap over single pile. The load shall be applied by means of standard hydraulic jack reacting against a loaded platform which shall be preloaded platform which shall be preloaded to three times the estimated safe load carrying capacity of the pile. Reading of settlement and rebound shall be recorded with four dial gauges of 0.01 mm sensitively and resting on diametrically opposite ends of the pile cap. The dial gauge shall be fixed to a datum bar whose ends rest-upon non-movable supports. The supports for datum bar with reference to which the settlement of the pile is measured shall be at least 5 times diameter of pile away from the pile.

The test shall be conducted by the cyclic loading method. The test load shall be applied in equal increments of about one-fifth of the estimated safe load. Each stage of loading or unloading shall be maintained till the rate of movement of the pile cap is not more than 0.02 mm per hour. However, load shall be maintained for longer periods at 1 to 1.5 times the assumed safe capacity, and at final loads as directed by Engineer. The safe load on pile shall be the least of the following :

- i Two third of the final load at which the total settlement attains the value of 12 mm.
- ii Two third of the final load at which the net settlement attains a value of 6 mm.
- iii 50 per cent of the final load at which the total settlement equals one-tenth of the pile diameter.

d) **Lateral Load Test on Trial Piles**

The test pile shall be decided by the Engineer. The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having an adequate area for proper seating of the jack and dial gauge. The lateral load shall be applied on the pile at or approximately at cut off level and the deflection shall be measured at a point diametrically opposite to the point of load application. The loading shall be applied by the hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the well of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap. Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg. Deflection of the pile head shall be measured by four dial gauges, fixed to datum bars & having a least count of 0.01 mm. The datum bars shall be provided with rigid

supports. Loading shall be applied in increments of 500 kg. Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.02 mm/hour or 1 hour whichever is greater .
Loading shall be continued till one of the following occurs :

- i. Deflection of pile head exceeds 12 mm.
- ii. The applied load on the pile is three times the assumed lateral load capacity of the pile.

The safe load shall be smaller of the following :

- i. Half the final load for which the total deflection is 12 mm.
- ii. Load at which the total displacement corresponds to 5 mm.

e) **Pull-out Test**

The test piles shall be decided by the Engineer. The test pile shall be built upto the proper length and the head provided with suitable arrangements for anchoring the load applying system. Loads shall be applied using a approved reaction system, uplift forces on the pile shall be applied directly to the test pile or through a lever system. The reaction shall be provided by neighbouring piles or blocks may be constructed for the purpose. Hydraulic jacks shall be used for load application. Load applied by the hydraulic jack shall be measured by a calibrated gauge with a least count of 100 Kg. Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. Four dial gauges placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports. The load shall be applied along the longitudinal axis of the pile using method approved by the Engineer. Loading shall be applied to the pile top in increment of one-fifth of the expected safe capacity. Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.02 mm per hour or four hours whichever is greater. Loading shall be continued till one of the following occurs :

- i. Yield of soil pile system occurs causing progressive movement of pile exceeding 12 mm.
- ii. The loading on the pile top equals three times the estimated safe load or as specified in the case of separate test pile.

The safe capacity of the pile should be least of the following :

- i. Two third of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible uplift, and
- ii Half of the load at which the load displacement curve shows a clear break (downward trend)

f) **Routine Test on Working Piles**

Three tests shall be carried out on working piles upto one and half times the design load and the maximum settlement of test loading in position being not exceeding 12 mm as per IS:2911 (Part IV). In case a pit foils under or during the load test, the Engineer shall select two additional piles in lieu of each of

such foiled pipe and the contractor shall carryout load tests on such additional piles.

18.9 Cast-In-Situ Piling Bored

The following specification deals with the requirements of materials, workmanship and installation of Bore Cast-in-situ reinforced concrete piles.

The materials and workmanship shall conform with the provision of the latest IS:456, IS:2911 (Part I, Section 2) & IS:2911 (Part 4).

Care shall be taken while boring piles so that no existing foundations / sub-structures are disturbed by providing suitable arrangements like shoring etc.

a. Sequence of Piling

The sequence of piles installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery.

b. Control of Alignment

Piles shall be installed as accurately as possible as per the designs and drawings either vertically or to the specified batter. Great care should be exercised in respect of installation of single pile or piles in two pile group. For vertical piles a deviation of 1.5 percent should not normally be exceeded. Piles should not deviate more than 75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm from their designed positions at the working level of the piling rig. In the case of a single pile in a column, positional tolerance should not be more than 50 mm (100 mm in case of piles having diameter more than 600 mm).

For piles carried to substantial depth, the design should provide for the worst combination of the above tolerance in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap and ties, the piles shall be replaced or supplemented by one or more additional piles, as directed by the Engineer, at no extra cost.

Any deviation from the designed location, alignment or load capacity of any piles shall be noted and brought to the attention of the Engineer and rectification and supplemental works carried out to the satisfaction of the Engineer at no extra cost.

A minimum length of one meter of temporary casing shall be inserted in each bored pile unless otherwise specifically desired. Additional length of temporary casing may be used depending on the condition of the strata etc.

Drilling mud of suitable consistency may also be used instead of temporary casings for stabilizing sides of the holes.

In case, a bored pile is stabilized by drilling mud the bottom of the hole shall be cleaned very carefully before concreting work is taken upon. The cleaning of the hole shall be ensured by careful operation of boring tool and / or

flushing of the drilling mud through the bottom of the hole. Flushing of bore holes before concreting with fresh drilling fluid/ mud is preferred.

In case a hole is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suitable interval of piles and recorded. Consistency of the drilling mud suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

The concreting operations should not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by tremie method in all such cases.

The top of concrete in a pile shall be brought above the cut-off level as per cl. 7.8 of IS: 2911 (Part 1/sec.2).

In case, defective piles are formed, they shall be removed or left in place, if so directed by the Engineer, if these do not affect the performance of the adjacent piles or the cap as a whole. Additional piles shall be provided to replace them as directed by the Engineer.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting, of the pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

The bentonite suspension used for piling work shall satisfy the following requirements:

- i. The liquid limit of bentonite when tested in accordance with IS:2720 (Part V) shall be more than 300 percent and less than 450 percent.
- ii. The sand content of the bentonite powder shall not be greater than 7 percent.
- iii. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared Bentonite solution should be between 1.034 and 1.10 gm/ml depending upon pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite solution after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.
- iv. The marsh velocity when tested by a Marsh cone should be about 37 seconds.
- v. The differential free swell shall be more than 540 percent.

- vi. The PH value of the bentonite suspension shall be between 9 & 11.5.

18.10 Codes and Standards

The following Indian Codes and Standards (Latest) shall be used for design of the structural elements:

IS:456: Code of Practice for plain and Reinforced concrete

IS:875: Code of Practice for Design loads (other than earthquake) for Buildings and structures.

IS:2911: Code of Practice for Design and Construction of Pile Foundations – Bored Cast-in-situ Piles (Part 1/sec. 2)

IS:2911 : Code of Practice for Design and Construction of Pile Foundation – Load Test on Piles (Part 4)

IS:1786 : Code of Practice for HYSD bars

IS:2751 : Code of Practice for welding of mild steel bars used for reinforced concrete construction

IS:2062 : Steel for general structural purposes

SP:16 : Design Aids for Reinforced Concrete to IS:456.

19.0 SURVEYING WORKS

19.1 Site survey shall be carried out to establish the ground levels and to determine any existing structures, roads etc. The site survey shall be carried out before the commencement of the work and if required during the progress of the work. The site survey shall be carried out at a grid spacing of 5-10 meters and at every change of level of the existing ground to produce contour drawings at 0.25 meter intervals. Scale of the contour drawings shall be as directed by the Consultant. A specialized firm approved by the Consultant shall carry out the site survey.

A single grid pillar will be given by the client with coordinates in plant area. Necessary grids shall be made by EPC contractor including demarcating the structures, buildings and jungle clearance including Cutting, uprooting and removing of trees and dispose the same away from the site etc.

19.2 Survey points (reference points and bench marks) : The contractor shall construct adequate number of reference points and bench marks for marking the setting out lines and levels. The reference points shall consist of suitable metal plates set in 400 mm x 400 mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level. All levels of the benchmarks shall be related to the agreed datum. The exposed numbers, locations, co-ordinates and level of the reference points and bench marks shall be plotted on drawings and approved by the consultant prior to the commencement of the work. Survey points in solid walls shall be stainless steel plates or cast iron, fixed firmly and sufficiently deep in the walls.

19.3 Safeguard of survey points: The survey points shall not be removed from their position without the permission of the Consultant. If any of the survey points are damaged or lost due to any work carried out near their location, the contractor shall be responsible for replacing such survey points.

19.4 Surveying during the progress of work : The contractor shall assist the consultant at any time when checking survey points, setting out, checking construction items and erection parts. The contractor shall provide and arrange the following:

- i.) Provision and maintenance of survey instruments and accessories.
- ii.) Provision of skilled personnel, supply of all material required for the survey exposing covered survey points.
- iii.) Shifting of any machinery used for construction out of the sight lines.
- iv.) Stopping all drilling, blasting, driving and any other works.
- v.) Causing soil vibrations and stopping during instrument observations
- vi.) Removing all obstructive accumulation of water
- vii.) Taking all necessary safety precautions
- viii.) Furnishing any marking material requested by the Consultant in connection with control surveys
- ix.) Providing additional survey points in accordance with the consultant's instruction.

20.0 EXCAVATION AND FILLING

20.1 The works to be provided by the bidder in respect of excavation in all types of soils including shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations shall be as detailed below:

- a. Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, equipment, tools and plants, transportation etc. required for the work.
- b. Prepare and submit working drawings showing the approaches, slopes, beams, 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 carryout sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.

20.2 All works should conform to the requirements of the latest revision of relevant ISS.

IS: 3764 : Indian Standard for Safety Code for excavation work.

IS:1200 (Part I): Indian Standard Methods of Measurement of Building and Civil Engineering work, Part-I: Earthwork.

20.3 The bidder should carryout the work as per the approved drawings. All materials required for the work shall be of best commercial variety. Borrow materials for back- filling shall be excavated from approved locations and shall consist of material, free from roots, vegetation, 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.

20.4 Quality Control: The bidder shall get approved the field quality plan, for maintaining the quality control for which, he shall establish and maintain quality control lab for the various aspects of the work, method, material 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.

Guide lines for quality control is attached in Vol-II of the specification.

20.5 Excavation

- a. **Setting out :** The contractor should submit to the Engineer, detailed drawings of the excavation work to be executed by him showing the dimensions as per drawings and specification adding his

proposals of slopes, shoring, approaches, dewatering sumps, beams etc. Upon Engineer's approval the contractor should 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 shall be fixed at intervals prescribed by the Engineer. The contractor should proceed with the work after Engineer's approval. It should be noted that this checking by the Engineer prior to start of the work shall in no way absolve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if necessary, should be carried out by the contractor free of cost to the Purchaser.

- b. Clearing and Grubbing etc.: The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out, the pit-holes formed shall be filled with good earth in 250 mm layers and consolidated. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils/ unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as specified. Useful materials, saleable timber, firewood etc. shall be the property of the Purchaser and shall be stacked properly at the work site in a manner as directed by the Engineer.

- c. Excavation in all kinds of soil: The excavation in all kinds of soil including old (from demolished structures) underground RCC / CC / brick masonry shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workman like manner without endangering the safety of nearby structures/ services or works and without causing hindrances to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Engineer thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall 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 carryout the balance work just before the foundation work of the structure can be started.
- d. Disposal: The excavated soils shall be disposed of within 8 km crow fly distance from site as directed by the Engineer-in-charge in any or all the following manners:
- i) By using it for backfilling straightway.
 - ii) By stacking it temporarily for use in backfilling at a later date during execution.
 - iii) By either spreading or spreading and compacting at designated disposal areas.

- iv) By selecting the useful material and stacking it nearly in areas designated by the Engineer for use in backfilling by some other agency.
- e. Disposal of Surplus: The surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer. All goods excavated from the pits and all assorted materials of dismantled structures shall be the property of the Purchaser.
- f. 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.

- g. Dealing with surface water : All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

- h. 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.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment and measurement, provided the Contractor has completed all the work satisfactorily.

- j. 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.
- k. Treatment of slips : The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

20.6 Back-filling

- a. The backfilling material shall consist of materials, 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.
- b. Filling and compaction in pits and trenches around structures: As soon as the work in foundations has been accepted and measured, the space 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 the satisfaction of the Engineer. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as 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 optimize the moisture content.

The backfilling shall be carried out at optimum moisture content to achieve 95% of Proctor's Maximum Dry Density.

- c. Plinth filling: The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted 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 slopes intended to be given to the floor.
- d. 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. 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.
- e. Filling in disposal area: Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within the lead for disposal as 8 km crow fly distance from the site. 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 shall 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.

20.7 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 plant. Sturdy and elegant fencing shall 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.

20.8 Lighting : Full scale area lighting should 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 filling.

20.9 Testing and Acceptance Criteria

- a. Excavation: On completion of excavation, the dimensions of the pits shall be checked as per the drawings. After the pits are completely dewatered,

the work shall 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 M10 proportion and/ or richer and/ or by compacted earth, as directed by the Engineer. Over excavation of the sides shall be made good while carrying out the back-filling. The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

- b. Back-filling: The degree of compaction required shall be as per IS standards and the actual method of measuring the compaction achieved shall be as decided by the Engineer. The work of back-filling shall be accepted after the Engineer is satisfied with the degree of compaction achieved.

21.0 WATER SUPPLY, DRAINAGE AND SANITATION

21.1 The technical details of surface drainage, storm water drainage, sewerage disposal system, sanitary appliances and water supply required for proper supply, drainage, disposal and completion of buildings are detailed below:

21.2 Surface Drainage

- a) All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.
- b) The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.
- c) The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.
- d) The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.
- e) The rectangular drains shall be minimum 450 mm wide of RCC construction. For minimum width of RCC rectangular drains along major roads refer Chapter 23 of this Specification. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However, for road crossings etc., pipe of class NP3 SHALL BE PROVIDED. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC.
- f) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum velocity for self cleansing of 0.8m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.
- g) Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.
- h) Garland drains minimum 300mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC grade 1:2:4 shall be provided between brick wall and drain with appropriate slope.
- i) The drainage system shall be designed for precipitation intensity of 80mm per hour. Run-off coefficients shall be considered as 0.6 and 0.9 for unpaved and paved areas (including roof, roads etc.) respectively.

21.3 Storm Water Drainage System



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- a) The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for a precipitation intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for Coal Storage area. These values shall be based on the recommendations of Indian metrological department (IMD).
- b) All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 300 mm wide at the base if trapezoidal sections are adopted and minimum 450 mm wide in case of RCC rectangular drains.
- c) For open trapezoidal drains, brick masonry lining on sides and bottom shall be provided. Bricks shall be laid in cement mortar and joints pointed flush. The thickness of lining shall be minimum 115mm. The lining shall be with fly ash bricks of class designation 150 laid in cement sand mortar 1:4 and flush pointed with cement sand mortar 1:2. The side slopes upon which lining has to rest shall be made such that no earth pressure is exerted upon lining in any conditions. However, the side slope shall not be steeper than 2 vertical to 1 horizontal. Alternatively, open drains trapezoidal in cross section may be provided in PCC lining of M15 grade. The thickness of PCC lining shall be minimum 100mm or as per design requirements whichever is higher.
- d) All open drains rectangular in cross section shall be in RCC. In the main plant block, rectangular section RCC drains in minimum M25 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.
- e) The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600mm. Beyond 600mm, box drains / culverts shall be provided.
- f) Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.8m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.
- g) Suitable manholes shall be provided to piped drainage lines at every 30m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- h) The cushion over the pipes for storm culverts shall be minimum 600mm. Where less cushion is available, pipe shall be cased in RCC m-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.

- i) Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.

The storm water drainage for the contaminated area such as coal stack pile, fuel oil area, oil skids etc. shall be designed separately and the discharge shall be led separately for treatment and disposal.

21.4 Waste Water Treatment and Drainage System

Waste water treatment plant will receive plant waste water and CT blow down. The treated water and the solid waste will be used within the plant.

The cooling tower blow down shall be pumped to CMB/Ash water sump.

All necessary civil / structural works for waste water treatment plant shall be under scope of contractor. The major source of plant waste water are Boiler blow down, coal mill area drainage, PH and boiler area oily effluent drain, F.O. pump house oil drainage, boiler and ESP area floor washing drains, water pre-treatment plant effluent, fly ash silo area effluent, transformer yard waste water etc. Civil/structural work for all other structures as per waste water system design requirement as described in relevant sections/volumes of this Specification shall also be provided by Bidder. Design and construction of all channels / settling pits / sumps / pipe lines / separators shall be done by the Bidder.

The description of some of the major structures / components covered under the waste water system package is given below:

Coal pile area run-off will be led to settling pond. R.C.C settling pond with two (2) compartments will be provided. Top of pond shall be 500 mm above surrounding finished grade level to restrict ingress of storm water from adjacent areas. Capacity of pond shall be determined on the basis of inlet drain invert. At the downstream of pond, RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in the specification. Necessary sluice gates with hoisting arrangement shall be provided in inlet drain carrying coal pile area run-off so that one settling pond can be operative while the other one under maintenance.

The Power House and boiler area service water waste shall be collected in a RCC underground oily waste sump pit. Necessary pumps and supporting floor / maintenance area shall be provided. This effluent will finally be treated in TPI (tilted plate interceptor).

Oil storage and handling area run-off will be collected to a conventional baffled oil water separator. This oil water separator will be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as un-cracked section as per IS:3370. The structure shall project at least 300 mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps will be installed.

RCC sump for collecting boiler blow down and ESP area floor washing is included in scope of bidder. Civil work for outlet of this effluent shall also be under scope of this package.

The Waste of DM plant and CPU will go to CMB, through neutralization pit.

All other structures not mentioned above but required as per waste water system design requirement shall be made of RCC (minimum grade M25) construction.

21.5 Sanitary Sewerage System

Sanitary Sewerage System shall be carried out as specified in VOL – III (Mechanical Spec.).

The treated water to be provided with necessary pumps and distribution lines for reutilization for Horticulture / Green belt development.

The sewerage system of foul water from toilet shall include layout and laying of sewers up to a sewage treatment plant together with all fittings and fixture and inclusive of ancillary works such as connections, installation of man-hole and inspection chambers. The construction of a sewage treatment plant of adequate capacity including settling tank, lifting stations, pump house and all other necessary provisions shall be made for treating the sewage water by using the latest CAACO technology developed by M/s. Central Leather Research Institute, Taramani, Chennai.

The domestic effluent from the plant shall be collected and treated in proper STP to meet the prescribed BIS standard before being discharged or reutilized for green belt development.

21.5.1 Sanitary Sewer Drains

- a) Sanitary sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec. and the maximum velocity shall not exceed 2.5m/sec.
- b) Very hot (over 60°C) water shall be first cooled down to less than 60°C in collecting basin by mixing with cold water before connecting to storm drainage system.
- c) The maximum temperature, quality, quantity and location of drain water of individual equipment shall be tabulated and furnished to the Owner's representative.
- d) All underground piping below concrete slab shall be cast iron of minimum 100mm dia and for outdoors it shall be reinforced concrete pipe of minimum 200mm diameter. In buried piping system manholes shall be placed at every change in direction and at every 30M (max.) interval in straight run. Suitable clean outs shall be provided for buried piping under floor slab.
- e) Following minimum drainage slope shall be provided:

- Pipes of diameter less than 200mm : 1 (vertical) : 100 (horizontal)
- Pipes of diameter 200mm & more: 1 (vertical): 200 (horizontal).

21.6 Sewerage Pipes

a) Glazed Stoneware Pipes

Glazed stoneware pipes of diameter not exceeding 150 mm can be used in localized areas not subjected to any traffic loads. The glazed stoneware pipes with spigot and socket ends shall conform to IS: 651 Grade "A" or "AA" as specified. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipe shall be free from erasing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The pipes shall be handled with sufficient care to avoid damage to them.

b) HDPE soil, waste, vent pipes and fittings

- i) HDPE soil, waste, vent pipes and fittings shall be of "Approved make" conforming to I.S. 4984-1995. The outer and inner surfaces of the pipes and fittings shall be smooth and clean and shall in all respects be free from cracks, pin holes, laps or other imperfections, which may impair the strength and durability of the pipes and fittings. The ends of the pipes shall be reasonably square to their axes.
- ii) The clamps for fixing the pipes to the external wall shall be of approved design and shall fit closely round the pipe or accessory directly beneath the socket.
- iii) The HDPE. soil, waste and vent pipes shall normally be fixed externally to the wall or in suitably designed shafts as per alignment shown on the drawings or as directed by the Engineer. The pipes shall be fixed and kept in position by means of brackets or holder clamps which shall be securely embedded in the wall. For vertical runs, each pipe shall hang freely on its own brackets fixed just below the socket. For horizontal runs, an additional clamp shall be provided at the centre. The brackets or clamps should be of such a design so as to maintain a minimum distance of 50 mm between the surface of the pipe and the wall.
- iv) The soil, waste or vent pipes shall be carried up, above the roof by a least 1.5 m and shall have a cowl of suitable design at the upper end.

c) RCC Pipes

- i) RCC pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm diameter NB. Pipes connecting various manholes shall be minimum 150 mm diameter NB. RCC Hume pipes shall be supplied and laid as required as per latest editions of the following IS codes:

IS : 458	:	Concrete pipes (with and without reinforcement)
IS : 783	:	Code or practice for laying of concrete pipes
IS : 4111(Part-1)	:	Code of practice for ancillary structure in sewerage system

- ii) The contractor shall supply the RCC hume pipes [class NP3/NP2] of various diameters along with fittings required for carrying out the work. The contractor should furnish manufacturer's test certificates from recognized authorities. PCC encasement shall also be provided whenever required as per design requirement.

iii) Alignment, Levels and Grade

The work shall be carried out in conformance to the alignments, levels and grades specified. The layout and levels shall be made by the contractor from one reference grid and bench mark given by the Engineer with the assistance of instruments, materials and men for checking the detailed layout and levels as and when required. Making of reference layout and level pillars along the pipeline route and maintaining them upto completion of the work shall be the Contractor's responsibility.

iv) Laying of Pipes

The laying of RCC pipes shall conform to IS:783. To suit the site conditions, the pipes should be laid as per drawings and instructions of the Engineer. Under the culvert condition, the pipe shall be laid under embankment and may project wholly or partly above the original ground surface.

Under trench condition, the pipe shall be laid in the excavated trench which shall be refilled with thoroughly tamped earth after laying and jointing of pipes in an approved manner. Adequate sand field cushioning shall be provided below pipes. Minimum depth of cushion shall be 600 mm.

Under open condition, the pipe shall laid such that it projects wholly or partly above original ground surface, there being no super imposed over burden on the pipe.

v) Bedding and Supports

Under culvert and trench condition, the pipes shall be laid generally on "First Class bedding" as per IS:783. If shown on the drawing or so instructed by the Engineer, the pipes can be laid on concrete cradles, conforming to IS:783. Minimum crushing strength shall be 140 Kg/sqm. Under open condition, the pipes shall be supported over rigid C.C. pedestals constructed at intervals not greater than the length of one individual piece of pipe, as per drawings and instructions of the Engineer. In no case shall the joint between two pieces of pipe shall lie at center of the span between the supports. The pedestal shall be of plain/reinforced concrete with a properly shaped out top to receive the pipe. Manholes shall be provided as per latest IS:4111 (Part-I) for pipe drains at the change of diameter of pipe, alignment and direction at a max. spacing of 30 m c/c upto 900 mm diameter and 45 m c/c for higher diameters of the pipe. Each manhole shall be provided with a heavy duty C.I. cover as per IS:1726.

d) Jointing



i) Glazed Stoneware Pipes

The cement mortar for jointing shall be 1:3 (1 cement: 3 fine sand) with spun yarn in neat cement. Tarred gasket or hemp/ spun yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed well into the socket of the pipe previously laid. Then pipe shall be adjusted and fixed in the correct position and gasket/ spun yarn caulked tightly so as to fill not more than $\frac{1}{4}$ th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 Degree with the barrel of the pipe. After a day's work any extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured.

ii) Jointing of RCC pipes

IS : 783 provisions shall be followed for jointing of pipes; and every possible care shall be taken to ensure that the joints made are leak proof. Curing of joints shall be done for a period of 10 days.

e) Testing of Joints

i) Stone Ware Pipes

Stone ware pipes used for sewers shall be subjected to test pressure of 1.5M head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the low end of the drain and the ends of the connection 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 vertical pipe jointed to it so as to provide the required test head. Or this 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.

ii) RCC pipes

All RCC pipe joints shall be checked for water tightness as per relevant IS code.

21.7 Water Supply

- a) All water supply pipes for internal plumbing of buildings shall be of GI pipe of medium class conforming to IS : 1239 of approved make. Galvanizing of pipes shall conform to IS : 4736.
- b) The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws, laminations and other defects; all screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the tube. The thickness and weight of pipes and sockets shall be in accordance with IS : 1239.

All screwed tubes and sockets shall have pipe threads conforming to latest IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

- c) The pipe fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements of clause No.3 or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to IS: 554 (latest edition). Female threads on fittings shall be parallel and male threads (except on running sipples and collars of unions) shall be taper.

d) Cutting, Laying and Jointing

Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to IS: 554 (latest edition) with pipe dies and tapes carefully in such a manner as well not result in slackness of joints when the two pieces are screwed together. The tapes and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joints. The screw threads of pipes and fittings shall be protected from the damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In joining the pipes, the inside of the sockets and the screwed end of the pipes shall be oiled and rubbed over with white lead; and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the sockets, tee etc. with the pipe wrench. Care should be taken that all the pipes and fittings are properly jointed so as to make the joints completely water-tight; and pipes are kept at all times free from dust and dirt during fixing. Bore from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after joining shall be painted or in case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

e) Fitting

- (i) For internal work, the galvanized pipes fittings shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm. clear of the wall. When it is found necessary to conceal the pipes chasing may be adopted or pipes fixed in the ducts or recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not be buried in walls or solid floors, where unavoidable pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a steel tube sleeve shall be fixed at a place a pipe is passing through a wall or floor for reception of

the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in wall or floors, it should be painted with anticorrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling done under concrete floors.

- ii) All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screw bolts. The clamps shall be embedded in brick work in cement mortar 1:3 (1 cement : 3 coarse sand) and shall be spaced at regular intervals in straight lengths as indicated below :-

Size of pipe (mm)	L E N G T H S	
	Horizontal runs (m)	Vertical runs (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3.5	3.5
65	3.5	5
80	3.5	5

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer.

- iii) For G.I. Pipes 15mm to 25 mm dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes, the holes shall be carefully made of the smallest size as directed by the Engineer. After fixing the pipes, the holes shall be made good with cement mortar 1:3 (1 cement and 3 coarse sand) and properly finished to match the adjacent surface.

21.8 Trenches and Other Excavations for Pipe Laying.

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.

21.9 a.) Water Closet

- (i) 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. All other buildings shall have minimum one toilet block each. The 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)

- (ii) The water closet shall be of Orissa pan/European type of approved make, Vitreous China conforming to IS: 2556 Part- III. The closet shall be of size as specified. The flushing rim shall be integral with the pan and shall be Self draining type. The closet shall be provided with a self cleaning trap of the same material as the pan. The trap shall be either a "P" or "S" outlet and with a vent hole. The effective depth of the water Seal shall not be less than 50 mm.
- (iii) The pan shall be fixed in position as shown on the drawing. It shall be embedded on a suitably prepared surface rendered smooth with neat cement or cement plaster so that uniform support is provided to the pan. The pan shall normally be at the floor level unless otherwise specified. The WC pan shall be fixed to the trap by means of a cement mortar joint as in the case of SW pipes; and the entire job carried out so that the effective seal is always kept maintained the vent of the trap being connected to Anti siphonage pipe.
- (iv) While laying flooring, a section about 1 x 1.5 m or less of the part of the floor where WC is to be fixed shall be left out. This shall be finished only after the pan has been fixed and laid in position. The pan shall be kept suitably protected against all damages. It shall include both pan and trap, as well as fixing materials as needed.

b.) Flushing Cisterns for Water Closets

The flushing cistern for water closet shall be of PVC low level type of 10 Ltr. capacity (IS 2556 mark) with PVC bend of approved make. The cistern shall be secured on wall or supported on steel brackets which shall be well embedded in the wall. The height of the bottom of the cistern from the top of the pan shall be 30 cm for low level cistern. The cistern shall be provided with brass balcock with ball to IS:1703. It shall include brackets, screw, flush pipes, brass ball cock with ball as needed.

c.) The Urinal shall be of first quality, White Glazed Vitreous china flat back conforming to IS 2556 of size as specified and of approved make. The urinal shall be fixed in position by means of four plugs embedded in wall and screws, the top of urinal lip being 65 cm from the floor level. Urinal bring a soil fitment should be connected to soil pipe. Each urinal shall be provided with 25 mm dia B Class GI Waste pipe connected to the pan by suitable joint and shall discharge in to a drain connected to a soil pipe through a trap. The flushing of urinal shall be with all fittings including photovoltaic control flushing system as per IS:2556 (Part-6 Section-1).

d.) The wash basin (oval shape) with all fittings as per IS:2556 made of vitreous China clay to be fixed on a concrete plat form finished with 12 mm thick polished granite stone. The basin shall be provided with single tap connection. The washbasin shall have an integral soap holder recess or recesses which shall drain into the bowl.

Each Wash Basin shall be provided with :

- i) 32 mm Ø CP brass waste fitting with CP brass chain and 32 mm dia plug.
 - ii) 25 mm Ø galvanized waste pipe "B" class discharging into a drain suitably connected to waste fitting by means of brass check nuts.
 - iii) 15 mm Ø CP pillar taps of superior quality to IS-8994 of approved make.
- e.) All toilets shall have at least one No. of exhaust fan. The No. of exhaust fan shall be decided as per ventilation requirements to maintain the high hygienic conditions in the toilet.
- f.) One number looking mirror 600 x 900 x 6mm, edge mounted with teak beading and minimum 12mm thick plywood backing, one number stainless towel rail 600 x 20mm, one number liquid soap dispenser.
- g.) One toilet with required facilities shall be provided for physically challenged persons as per National Code requirements in GRIHA rated buildings.
- h.) 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 and any other building as per functional requirement.

- i.) Janitor Space & Space for drinking water cooler.
- j.) Electric operated hand dryer with photo voltaic control.
- k.) The pantry shall consist of one number stainless steel pantry sink, as per IS:13983, of size 610 x 510mm, bowl depth 200mm with drain board of at least 450mm 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 12mm dia of medium class, cast iron sanitary pipe (with lead joints) of minimum 75mm 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)

- l.) Laboratory sink shall be of white vitreous china of size 600x400x200mm conforming to IS:2556 (Part-5)
- m.) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction state.

22.0 SWITCHYARD CIVIL WORKS

22.1 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. Switchyard Control room building, 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 rigid pavement roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,
- f. All necessary embedments, inserts, supporting structures & supporting members as required etc.
- g. Cable trenches in switchyard and inside control room building including civil works for panel fixing etc.
- h. For prevention of vegetation, the well-compacted and graded ground shall be treated with anti-weed treatment followed by 100mm thick moorum layer and then 150 mm thick gravel layer in the switchyard area.

22.2 Design Criteria

22.2.1 Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to Grade IS:2062 or IS:8500 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 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.

Girders shall be assumed to be simply supported on the tower at the ends. They will be resolved into plane trusses and analysed for the design loads. The main chords will be designed for bending moments and bracings for shear forces.

Towers will be analysed as self-supporting lattice structures. Bracings will be designed for shear forces and main legs for bending moments. Due regard will be given to the relief provided to the bracing members by the horizontal component of the inclined main leg forces. As a whole, the towers will be designed as vertical cantilever trussed-beam.

While designing towers, girders, equipment supporting structures, etc., adequate electrical clearances as stipulated in the relevant Indian standards/codes, rules and/or regulations must be considered.

All towers including lighting towers shall be designed for diagonal wind condition. Diagonal wind shall be taken as 1.4 times the wind calculated on Longitudinal/Transverse side.

22.2.3 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) Temperature load,
- 6) Loads due to deviation of conductor (gantries shall be checked for + 30 deg. deviation in horizontal plane and ± 20 degree deviation in vertical plane),
- 7) Loads due to unbalanced tension in conductor/wire,
- 8) Torsional load due to unbalanced vertical and horizontal forces,
- 9) Erection loads,
- 10) 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 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.

22.2.4 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.

Design of foundation shall be carried out as per IS Code 091.

Design consideration for switchyard equipment support:

The supporting structure for B.P.I., LA, CVT & Isolator equipment's shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1161 & 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 2026 and shall be designed as per IS: 802. Common raft foundation shall be provided for each pole of isolator.

22.2.5 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 mass 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.

22.2.6 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/ equipments/ 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.

22.2.7 The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.

22.2.8 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.

22.2.9 All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanized. After fabrication Minimum section thickness should not be less than 4 mm. The Weight of zinc coating shall be at least 0.910 kg/m². Zinc required for galvanizing shall be 99.5% as per IS:209. All burrs and irregular edges shall be ground smooth before galvanizing.

The galvanized steel member shall withstand in copper sulphate solution as per IS:2633. When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumpng'. The process known as 'wiping' or 'scrapping' shall not be used for this purpose. Spring washers shall be electro-galvanized.

The design of foundation should take care of sub soil water pressure as per relevant IS Codes.

22.2.10 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. The design of trenches to take care of sub soil water pressure as per relevant IS Codes.

22.2.11 Gravel Filling:

Gravel 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 gravel 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. The gravel layer shall be placed over 100mm thick moorum layer.

22.2.12 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 gravel 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 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 gravel filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

23.0 CONCRETE ROAD AND RIGID PAVEMENT**23.1 Plant Roads**

Access within the plant site shall be provided by a system of roadways.

All building shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement. Access roads shall also be provided to areas such as transformer areas, steam generator area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

Roads shall be three types: Type I, Type II and Type III. All the roads inside the plant area shall be of reinforced cement concrete of minimum 25 cm thick.

Type I roads shall consist of minimum 10.0 metres wide RCC paved carriageway with 2.0m wide hard shoulders. The main plant access road and a portion of the main plant complex circumferential road shall be Type I. Final approved Plot Plan shall be followed for actual width and layout/location of Type-I roads.

Type II roads shall consist of minimum 4.5 metre wide RCC paved carriageway with 1.5m wide hard shoulders with drains on either side. A turning area at blind ends shall be provided. Plant areas where infrequent access is needed shall be served by Type II roads. Examples of Type II roads are the lay-down area roads. Final approved Plot Plan shall be followed for actual width and layout/location of Type-II roads.

Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance. Final approved Plot Plan shall be followed for actual layout of Type-III roads.

A 4.0 m wide RCC road with 1m shoulder on both sides shall be bild/constructed all along the outside of the boundary wall of the plant.

All the roads shall be constructed before start of construction activities for power house and shall again be repaired / made good after completion of construction of activities i.e at the time of handover / project.

Road leading to main gate of power house shall be double lane road with suitable berm. Minimum thickness of road shall be 25 cm and width of 7.5m each.

All Type I roads shall have a minimum turning radius of 10 meters and for Type II and Type III roads shall have a minimum turning radius of 7 meter.

Boulders shall be provided along side of all type of roads near equipment which requires protection. Spare duct bank shall be provided under all type roads spaced at 100m intervals.

Modification / repair of existing 4.0m wide road with 1m shoulder on both sides all along the existing ash dyke shall be in Bidder's scope. The existing road should be modified to RCC road.

Signs shall be provided for vehicle management and shall meet the Indian standards. All signs shall be dual worded in both English and the local Indian language. Finished top (crest) of roads shall be as per CEA guide lines. Geometric design of road shall be in accordance with IRC:73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

The shoulder shall be laid with slope of 1 in 30.

Top level of parking area shall be flushed with crown connecting roads with cross slope. Parking area shall be provided rigid pavements & shall be provided with anti skid tiles.

On either side of type I and type II roads and on one side of type III roads, open drains shall be provided. Minimum clear width of drains shall be 600mm. The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. All service and utility lines crossing the roads shall be taken through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast in place RCC box culverts. No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The Roads must be designed for the heaviest equipment of the plant and before designing the CBR test to be carried out. Road shall be designed as per IRC & MOST standards. (MORTH)

The Cross section for road shall be as follows:

- i The Sub-grade shall be 250 mm thick Granulated Sub-base compacted to 95% dry density.
- ii 250 mm thick metal finish.
- iii 100mm thick dry lean concrete
- iv A separation membrane shall be used between concrete slab and the sub base. Membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases
- v Pavement 250 mm thick M30 mix, with single mat reinforcement of 12 tor @ 300 c/c both ways.
- vi The drainage system shall be designed for precipitation intensity of 80mm per hour.
- vii. Necessary expansion joints and contraction joints including details shall be provided in RCC roads as per relevant IRC Codes & Standards.

The specified is minimum and indicative and the contractor has to provide roads as per functional requirements.

The detailed specification may be prepared including construction and Expansion Joint

VOLUME VII : <u>TENDER DRAWINGS LIST</u>		
CONTENTS		
S. No.	Title	Drawing Number
	Section : Mechanical	
1.	PLOT PLAN	14A14-DWG-M-001
2.	LEGEND	14A14-DWG-M-002
3.	GROUNG FLOOR PLAN AT E. 0.00M	14A14-DWG-M-003
4.	MEZZANINE FLOOR PLAN AT E. 8.5M AND 12.0m	14A14-DWG-M-004
5.	OPERATING FLOOR PLAN AT E. 17.0M	14A14-DWG-M-005
6.	TG BUILDING CROSS-SECTION	14A14-DWG-M-006
7.	Flow Diagram Steam & Feed Water	14A14-DWG-M-007
8.	Scheme for Condensate	14A14-DWG-M-008
9.	Scheme for Feed Water	14A14-DWG-M-009
10.	Flow Diagram Air & Flue Gas	14A14-DWG-M-010
11.	Scheme Extraction Steam for Heaters	14A14-DWG-M-011
12.	Flow Diagram Aux Steam System	14A14-DWG-M-012
13.	Scheme for Pulveriser	14A14-DWG-M-013
14.	Composite Water Scheme	14A14-DWG-M-014
15.	P&ID Pre-Treatment Plant	14A14-DWG-M-015
16.	P&ID DM Plant	14A14-DWG-M-016
17.	P&ID CPU	14A14-DWG-M-017
18.	P&ID Service Water Distribution System	14A14-DWG-M-018
19.	P&ID Potable Water Distribution System	14A14-DWG-M-019
20.	P&ID Potable & Raw Water Chlorination	14A14-DWG-M-020
21.	P&ID CW Chlorination System	14A14-DWG-M-021
22.	CW Chemical Dosing System	14A14-DWG-M-022
23.	CW Acid Dosing System	14A14-DWG-M-023
24.	P&ID Effluent Treatment Plant	14A14-DWG-M-024
25.	P&ID CLARIFIED WATER SYSTEM	14A14-DWG-M-025
26.	P&ID Hotwell Makeup & Boiler Fill System	14A14-DWG-M-026
27.	Flow Scheme Sewage Treatment Plant	14A14-DWG-M-027
28.	P&ID Raw Water System	14A14-DWG-M-028
29.	SITE PLAN	14A14-DWG-M-029
30.	P&ID CW & ACW System	14A14-DWG-M-032



VOLUME VII : TENDER DRAWINGS LIST		
CONTENTS		
S. No.	Title	Drawing Number
31.	P&ID DMCW SYSTEM	14A14-DWG-M-033
32.	P&ID For Fire Water Pump House	14A14-DWG-M-034
33.	P&ID For Foam System For HFO & LDO Tank	14A14-DWG-M-035
34.	P&ID For Centralized Inert Gas Flooding System	14A14-DWG-M-036
35.	P&ID Compressed Air System	14A14-DWG-M-037
36.	P&ID For Fuel Oil And Light Diesel Oil Unloading System	14A14-DWG-M-041
37.	P&ID For Fuel Oil And Light Diesel Oil System Up To Boiler	14A14-DWG-M-042
38.	P&ID For Light Diesel Oil Supply To Boiler	14A14-DWG-M-043
39.	Flow Diagram (For Coal Handling Plant)	14A14-DWG-M-044
40.	Layout Plan of CHP	14A14-DWG-M-045
41.	Typical Scheme for Air Washer Unit	14A14-002-DWG-VA-001
42.	Typical Scheme for Unitary Air Filtration Unit	14A14-002-DWG-VA-002
43.	Typical Detail of Wall Mounted Axial Flow Fan & Roof Extractor	14A14-002-DWG-VA-003
44.	Typical Scheme of Air Distribution System for Power House Building	14A14-002-DWG-VA-004
45.	Schematic Drawing for Vapour Absorption Machine & Water Cooled Screw Chiller	14A14-003-DWG-VA-001
46.	Schematic Diagram of Water Cooled Precision Air-Conditioner	14A14-003-DWG-VA-002
47.	Schematic Diagram of Air Cooled Precision Air-Conditioner	14A14-003-DWG-VA-003
48.	Schematic Diagram of Air Cooled Split AC Unit	14A14-003-DWG-VA-004
49.	Flow Diagram Bottom Ash Handling System	14A14-DWG-M-AHP-001
50.	Flow Diagram Coarse Ash Handling System	14A14-DWG-M-AHP-002
51.	Flow Diagram Fly Ash Handling System (ALTERNATIVE-1)	14A14-DWG-M-AHP-003A
52.	Flow Diagram Fly Ash Handling System (ALTERNATIVE-2)	14A14-DWG-M-AHP-003B
53.	Flow Diagram Ash Water Recovery System	14A14-DWG-M-AHP-004
54.	Flow Diagram Ash Slurry & Water System	14A14-DWG-M-AHP-005
55.	Flow Diagram HCSD System	14A14-DWG-M-AHP-006
56.	Flow Diagram Mill Reject Handling System	14A14-DWG-MRHS-001

VOLUME VII : TENDER DRAWINGS LIST		
CONTENTS		
S. No.	Title	Drawing Number
57.	Conceptual Plan for Remodelling of Panki Thermal Power Station Yard	RITES-LKO/PNK-01
	Section : Electrical	
1.	Single line diagram 400Kv Switchyard	14A14-DWG-E-0101
2.	Electrical Single line diagram for auxiliary power distribution	14A14-DWG-E-0102 (Sht 1 & 2)
	Section : Control & Instrumentation	
1.0	System Configuration Drawing for DDCMIS	14A14-DWG-I-0001
2.0	PLC Configuration drawings	14A14-DWG-I-0002
3.0	Station LAN	14A14-DWG-I-0003
4.0	BMS (Burner Management system - TMR Configuration)	14A14-DWG-I-0004
	SWAS (Steam and water analysis System)	14A14-DWG-I-0008
5.0	DMS (Documentation Management system)	-
	Hook ups (Installation Drawings)	14A14-DWG-I-0010
6.0	PADO	14A14-DWG-I-0011
	Panel (GA of Control Desk & LVS)	14A14-DWG-I-0012
	24 V DC System Single Line Diagram	14A14-DWG-I-0020
	UPS Single Line Diagram	14A14-DWG-I-0021
	Drive Interface Scheme	14A14-DWG-I-0022
7.0	PSSS (Plant security and surveillance system)	14A14-DWG-I-0031
8.0	Simulator	14A14-DWG-I-0032
9.0	Junction Box Wiring	14A14-DWG-I-0033
10.0	PA System	14A14-DWG-I-0034

Note: -

Bidder to note that equipment / valves / instruments / analysers indicated in P&ID / flow schemes is minimum. However any other additional requirements regarding quantities & type of equipment / valves / instruments / analysers shall be finalized by Owner / Consultant during detailed engineering as per process & redundancy requirements as stipulated in NIT/Technical specification.



EPC Package for 1x660 MW Panki TPS Extension Project
CLARIFICATIONS TO PRE-BID QUERIES OF BHEL Annexure- 1D (PEM)

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	COMMENTS / CLARIFICATIONS	OWNER'S REPLY
	VOL./ PART	SEC/ CHAPTER	PAGE NO.	CLAUSE NO.			
AC & Ventilation							
1.	Vol III	Chapter 25	3 of 40	25.3.7	The occupancy for general area shall be minimum one person per 3 Sq. M and for conference room the same shall be one per 1.5 Sq. M. In the control rooms, control equipment rooms etc, the occupancy may be one PER- SON PER 20 SQ. M rooms, control equipment rooms etc, the occupancy may be one PER- SON PER 20 SQ. M (MINIMUM). may be one PER- SON PER 20 SQ. M (MINIMUM).	The occupancy figures mentioned are on very higher side. As a standard practice occupancy for general area is considered as one person per 10 Sq. M, 3 Sq.M for one person in conference room, and one person per 25 Sq. M in control rooms, control equipment rooms etc,	We have reviewed the requirement. However BHEL is to strictly follow the specification as no deviation is acceptable.
2.	Vol III	Chapter 25	4 of 40	25.3.14	Underdeck insulation of 50 mm nominal of glass wool (32 kg/cu. M) or rock wool 8 kg/cu.m) shall be provided if: i) Non A/C area is located just above the A/C area .In this case underdeck insulation shall be provided underneath the ceiling of A/C area. ii) None A/C area is located just below the A/C area. In this case, underdeck insulation shall be provided underneath of the ceiling of non A/C area.	Customer is requested to review the requirement and confirm acceptance. Bidder proposes to provide Underdeck insulation underneath of the ceiling of AC areas/AHU/PAC room which are directly exposed to sun. Please confirm acceptance.	
3.	Vol III	Chapter 25	7 of 40	25.4.1 (vii)	DG set room-45 Air Changes per hour	Customer is requested to review the requirement of 45 ACH in DG set room. As a standard practice air changes in DG set room is considered as 30 Air Changes per hour. Please confirm acceptance.	

7.	VI/ 2	Scope of Work	2 of 8	24	Raw water reservoir (storage capacity shall be as described elsewhere in this specification) for running of 1x660MW unit during canal closing period is in the scope of bidder.	Referred clauses 4.1.3 III/4 on capacity of raw water reser- voir (10 day capacity), UPRVUNL to Please confirm the same.	Confirmed.
8.	VI/ 02	Scope of Work	6 of 8	2.6.75	Rain Water Harvesting should be im- plemented as per the scheme/design approved. Central ground water Au- thority/Board or State ground water authority or MOEF authorized agency shall be consulted for finalization of	Rainwater Harvesting scheme shall be furnished to UPRVUNL / Consultant by bidder for approval. UPRVUNL may further get approval of scheme by any authorized agency. Please confirm	Requirement of specification shall prevail.
9.	III/ 13	Rain Water Harvesting	1 of 3	13	Rain Water harvesting pond capacity shall be minimum 50,000 cum.	The capacity of rainwater harvesting pond seems to be on higher side. However if required, the location of same may please be specified.	Refer Plot Plan.
10.	VI/07	Material	1 of 1	7.2	Ordinary Portland Cement (OPC) Grade 43 shall be used for all struc- tures.	Usage of Portland pozzolana cement (PPC) may also be allowed in some areas. Please confirm.	Bidder to follow specification.
11.	VI/ 11	Building Description	Sheet 16 of 19	11.15.3	RAW WATER RESERVOIR....The bot- tom of the reservoir shall be of cast in situ R.C.C. panels in concrete Below the RCC bed HDPE lining work shall be provided.....	HDPE lining work in RCC raw water reservoir is not required. Please confirm.	Bidder should adhere to requirement of specification.
12.	VI/ 11	Building Description	15 of 19	11.15.1	RAW WATER RESER- VOIR.....Pressure relief valves of ade- quate capacity and in sufficient number shall be provided	We are considering pressure relief valves at the bottom raft of RCC raw water reservoir as per clause no 11.15.1. Please confirm.	Pressure Relief Valve (PRV) is allowed at base raft of RCC Raw water Reservoir and CW forebay basin only. PRV not allowed in any other structure under this package as per Cl. No. 10.3 e
13.	VI/ 10	RCC Struc- ture& Founda- tions	1 of 43	10.3.e	In all liquid retaining structures, pvc water bar shall be provided at each construction / expansion joint. No pres- sure reliving devices shall be permitted in underground structures except fore bay.		

19.	VI/ 02	Scope of Work	4 of 8	2(55)	Minor Site grading and levelling upto 500 mm is in the scope of bidder. Finish ground level of entire plant area will be RL....m above mean sea level. FFL of all other buildings, roads and drains will be	FGL and HFL to be confirmed by customer. The same is not mentioned in the Plot Plan. Please confirm.	Plant FGL. RL. (+) 126.0 M Ref. Vol.-II Book 1 of 2 Ch. 02; CI No. 1.0; Page No. 1 of 7.
20.	VI/ 06	General Requirement of Building & Structure	8 of 11	6.13	The road near the main entrance to be widened additionally by 7.5 m on either sides of the road for parking of vehicles for security check.	Please provide the length of road which has to be widened additionally by 7.5m on either side.	Please refer Plot Plan for additional information.. Bidder may visit site.
21.	VI/ 23	Concrete Road & Rigid Pavement	1 of 3	23.1	Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance....A 4m wide RCC road with 1m wide shoulder on both side shall be constructed all along the outside of the boundary.....	The road (Type-III) outside along the plant boundary shall be constructed as per this clause. No patrol road along inside boundary shall be constructed as the same has neither been indicated in the specification nor cleared in plot plan. Further leveling and grading for this road shall be provided by Customer. Please confirm.	Type-III road (3.0 m wide RCC road) is the patrol road along inside of plant boundary for access for security & maintenance. 4 m wide RCC road around outside of the boundary is in addition to patrol road inside boundary.

22.	VI/ 12	Reinforced Concrete Chimney	5 of 22 & 13 of 22	12.3.10 (10) & 12.13	As per Cl. 12.3.10 (10) "Embedment to support the stair case shall be provided in the shell", it is implied that staircase is supported on shell. However, as per Cl. 12.13 "The stair-case shall be supported by a structural steel framework supported from platform to platform independently of the wind shield."	The referred clauses are contradictory. Staircase provided directly on platform as per clause 12.13, would result in large platform girders, consequently large openings in windshield, which would be zone of weaknesses in the windshield. Further platforms are placed with sliding connections in windshield; placing stair- case of around 40m on platform would result in stability issues under earthquake and other dynamic conditions. Therefore the standard practice of staircase erected on brackets supported from windshield may be followed as mentioned in clause 12.3.10 (10). Please Confirm.	Stairs should be supported between platform as per Cl. No. 12.3.10 (10). However, some minor connections may be taken wind shield if required.
23.	VII/ 12	RCC Chimney	16 of 22	12.23	"The laser scanning of chimney shell after every 70 m height and on completion should be performed". "	Kindly clarify whether this laser scanning is for verticality check only, or it is for entire shell surface profiling check.	Cl. No. 12.23 is very clear in this regard.
24.	VI/8	Loading	4 of 5	8.6	Basic wind speed at project site is 39 m/sec. as per IS:875 -1987 Part-3	There is contradictory over Basic wind speed as per clause 8.6 (39 m/s) & 12.3.7 (47m/s). Changing basic wind speed from 39m/s to 47m/s would lead to an increase of 45% pressure. Please clarify.	Basic wind speed shall be considered as 47 m/sec.
	VI/12	RCC Chimney	3 of 22	12.3.7	Wind parameters to be considered for calculating design wind speed and pressure shall be as follows. Basic wind speed = 47 m/s (upto 10m above normal ground level) as per IS: 875 (Part-3): 1987.		
25.	VI/13	IDCT	1 of 25	-	Chapter name is IDCT, but inside the details are of NDCT.	Chapter name is IDCT, but inside the details are of NDCT. Please clarify.	NDCT should be considered instead of IDCT.
26.	VI/6	General requirement of Building & Structures	8 of 11	6.12	Suitable drains shall be provided... The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain.	Disposal point of Plant Storm water drain to be confirmed. It is understood that this storm water drain shall be connected to the nearest existing main drain inside plant. Please Confirm.	Disposal point shall be intimated during detail engineering. Bidder may visit site to have better idea & collecting relevant data

27.	VI/17	Architectural Works	2 of 21	17.2 (v)	All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS: 1161 and shall be galvanized as per IS: 4736 treated with primer and finished with suitable paint.	As per mentioned clause, handrails pipe dia shall be 50mm NB (Except at operating floors) whereas as per clause Ch.06, 6.8, page 3 of 11, all handrails shall be of 32mm NB. Bidder understands that clause Ch. 06, 6.8 page 3 of 11 shall prevail i.e. all handrails shall be of 32mm NB. Please confirm.	Noted.
28.	VI/17	Architectural Works	2 of 21	17.2 (v)	All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.	All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB MS Galvanized pipes shall be provided.	Noted.
29.	VI/17	Architectural Works	7 of 21	17.7.4(a)	To suit the spacing of purlin, the length of sheet may vary between 1.50 to 2.00 m.	The length of sheet shall be as per manufacturer standard.	Requirement of specification prevails. However, this shall be finalized during detail engineering.
30.	VI/21	Water Supply, Drainage & Sanitation	1 of 12	21.2(b)	The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 Meters.	For a drain slope of 1 in 1000 (min), paving slope shall be fixed in detailed design as per Storm water quantity. Further, the network & spacing of drain shall be decided in detailed engg. Please confirm.	Confirmed. However, requirements of spfn. must be satisfied during detail engineering.
31.	VI/2	Scope of work	4 of 8	2.6 (57)	Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout...	The customer shall furnish to the bidder the obstacle free area which shall be suited for construction. Also the length for which security wall has to be made may please be mentioned. Height of the security wall needed may also be indicated.	Bidder may visit site to collect the data.
32.	VI/2	Scope of work	2 of 8	2.6 (14)	Modification (if required) of existing return channel...	Owner to clarify the length and layout of return channel on Plot Plan to be modified.	During detail engineering.
33.	VI/2	Scope of work	2 of 8	2.6 (22)	raw water pump house (intake structure) to be constructed inside plant boundary near the Lower Ganga Canal to pump the make-up water through MS pipes to Raw Water reservoir. Desilting chamber adjacent to raw water pump house to remove the silt from incoming water from Lower Ganga Canal is also in the scope of Bidder	All necessary statutory clearance required to construct raw water pump house (intake structure) near the lower ganga canal shall be in Owner scope. Further, the removal of minimum silt size to be confirmed. The size of the desilting chamber may also be informed.	Obtaining statutory clearances under Bidder's scope. During detail engineering.

34.	VI/17	Architectural Works	17 of 21	17.7.9	All the exposed structural steel i.e. wall, columns, bracings in STG control room and air-conditioning areas shall be provided with wooden wall paneling.	As wood is prone to fire hazards, bidder understands that portion of the structural steel column projecting into the room in STG control room and air conditioned area shall be encased with brick masonry to shield it from fire hazards. Please confirm.	Bidder to follow specification. Necessary precaution for fire prevention shall be taken care by bidder.
35.	VI/11	Building Description	7 of 19	11.3	Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor up to 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent color coated Galvanized trough sheet cladding shall be provided.	As per Bidder's standard practice, permanent color coated galvanized trough sheet cladding shall be provided from tripper finished floor level up to tripper roof. Please confirm.	Requirement of specification to be followed by the bidder.
36.	VI/1	Code & Standard	9 of 11	1.15	IS: 800 Code of practice for use of structural steel in general building construction.	Design of steel structures shall be as per IS 800: 1984. Please confirm	Confirmed.
37.	VI/14	CHP	18 of 25	14.2	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."	Bidder requests that tubular / hollow section shall be allowed in BOP buildings, Truss & Pipe racks. The minimum thickness for tubular/hollow section shall be as per IS 806 -1968. Please confirm.	Not acceptable. Tubular section should only be provided in structures as specifically mentioned in specification, if any.
38.	VI/11	Building Structure	7 of 19	11.3	Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min. 50 thick screed over the water proofing treatment.	To avoid high temperature and heat inside tripper floor, it is suggested to provide insulated cladding sheet in bunker roof instead of RCC over that sheet. Please confirm.	Bidder to follow specification.
39.	VI/10	RCC Structure foundation	26 of 43	10.19	Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings	For which machine foundation Rubber pad is required to be clarified.	As per mechanical specification & approved GA drawings.

40.	-	General	-			It may please be informed whether any existing under- ground facility is coming below the proposed location of the power plant buildings and utilities. In case same is there, details of the same may please be furnished to the bidder.	Shall be informed during execution stage. For further detail bidder may visit site.
41.	VI	Chapter no 12	Sheet 3 of 22	12.3.7	K2 = (TABLE 2 & TABLE 33, CATEGORY = 1 , CLASS-C)	Please note that as per IS 875 PART(iii), the subject site lies in terrain category II. Terrain category I is taken as most severe category of wind force, generally taken at open sea areas, for the subject site this would lead to significant overestimation of wind forces.	Stipulation of specification should strictly be followed by bidder.
42.	VI	Chapter no 12	Sheet 3 of 22	12.3.10	The heat insulation of the liners and <u>pressurized ventilation</u> system shall be so designed that temperature in annular space between the chimney shell and flues does not exceed 45 Deg.C in peak summers.	Pressurized ventilation system is neither possible nor required in single flue steel liner with gratings platforms. Therefore, natural ventilation shall be provided. Please confirm	Confirmed. Also refer Cl. No. 10.3.9
43.	VI	Chapter no 12	Sheet 13 of 22	12.15	Lift shall be provided for the chimney <u>inside</u> the wind shield.	Lift shall be provided for the chimney outside the wind shield. This is already adopted as a standard practice for all single flue brick liner chimneys. <u>Please confirm</u>	Steel flue to be provided as per specification. Hence, lift shall be placed inside.

47.	General	-	-	-	-	Bidder understands that the transmission line crossing the proposed BTG location and Cooling tower location shall be re-routed by owner and a free land shall be provided to contractor for construction. Please confirm if bidder's understanding is correct.	Confirmed.
48.	General	-	-	-	-	Bidder understands that the sewer line and supply water system line shall be re-routed by owner for the existing colony (if required) during construction.	To be done by bidder.
49.	Sewage Treatment Plant					Customer is requested to inform if sewage treatment Plant is to be constructed by bidder or existing Sewage Treatment Plant shall cater the requirement of proposed unit.	Refer Cl. 21.5 of Ch.-21
Control & Instrumentation							
1.	V/Part-B	Ch.1	3 of 8	1.04.01	Bidder shall ensure that various C&I instruments/equipment..... are of the same make, series and family of hard- ware.	As per bidder's policy, C&I instruments /equipments, PLC systems, UPS systems shall be provided from approved Vendor list/make & OEM recommendation for BOP pack- aged sub systems. Same make/ type/ model/ manufacturer of C&I equip- ments/ instruments, PLC systems, UPS systems is not possible.	As per specification.
	V/Part-B	Ch.14	10 of 11	11	All the PLC control system shall be of same make/model/family.		
2.	V/Part-A		2 of 90	2.01.00 (viii) - 7	Automatic Unit Start-up & Shutdown	Automatic unit startup & shutdown will be performed by independent startup & shutdown sequence of various plant groups/sub groups for major equipments with minimum operator intervention.	Noted. Exact details shall be finalized during detailed engineering.
3.	V/Part-A	Ch.14	35 of 90	3.0.0	24 V DC Power Supply system shall be of continuous duty as mentioned in Subsection "Uninterruptable Power Supply System & 24 V DC systems", chapter 7, Part-B, Vol. V shall be provided on as required basis meeting the specification requirements and taking care of the	24V DC power requirement for control system shall be derived from 230V UPS supply using redundant 24V DC power packs in the panel. No separate 24V DC power system (employing separate battery & battery charger) is envisaged for DCS, PLC and microprocessor based control system as per practice widely followed. Please confirm	As per specification

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
1.	Vol. VI Ch. 2	2 of 8	2.6 (19)	Cooling tower switchgear and MCC Room	Clause shall be read as : 19. Raising and strengthening of existing ash dyke
2.	Volume- VI Ch. 11	2 of 19	11.1.9	Contractor to establish a Fly Ash Brick Plant at site to fulfil the requirement of Fly Ash Bricks for the project.	Clause shall be read as : Contractor to establish a Fly Ash Brick Plant at site to fulfill the requirement of Fly Ash Bricks for the project. Available Fly ash shall be provided free of cost by UPRVUNL.
3.	Volume- VI Ch. 15	1 of 3	15.1	Works shall include bottom ash hopper supports, dry silos, development of silo area (including paving, fencing, access roads, office block and watchman cabin), pump facilities required to complete the system.	Clause shall be read as : Works shall include bottom ash hopper supports, dry silos, development of silo area (including paving, 2100mm high compound wall with 600mm high fencing at top , access roads, office block and watchman cabin), pump facilities required to complete the system.
4.	Volume- VI Ch. 17	2 of 21	17.2 (V)	All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736	Clause shall be read as : All handrails and ladder pipes (except at operating floors) shall be 32mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736 or Cl. No. 6.8 of Chapter 06 whichever is stringent.

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

5.	Volume- VI Ch. 17	2 of 21	17.2 (V)	All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided	Clause shall be read as : All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB galvanized steel pipe shall be provided. Galvanizing shall be as per IS:4736 or Cl. No. 6.8 of Chapter 06 whichever is stringent.
6.	Volume- VI Ch. 19	1 of 1	19.1	Necessary grids shall be made by EPC contractor including demarcating the structures buildings and jungle clearance including Cutting, uprooting and removing of trees and dispose the same away from the site etc.	Clause shall be read as : Necessary grids shall be made by EPC contractor including demarcating the structures/ buildings , jungle clearance, as necessary and dispose the same away from the site etc.
7.	Volume- VI Ch. 20	1 of 4	20.3	Borrow materials for back-filling shall be excavated from approved locations and shall be used as fill material.	Clause shall be read as : Borrow materials for back-filling shall be excavated from approved locations and shall be used as fill material. Identification, acquisition and right-of-way of borrow area shall be in Bidder's scope.
8.	Vol. VI Ch. 8	4 of 5	8.5	Seismic analysis shall be carried out as per the latest edition of IS:1893 (Part 1 & 4). Zone-IV shall be considered for design.	Clause shall be read as : Seismic analysis shall be carried out as per the latest edition of IS:1893 (Part 1 & 4). Zone-III shall be considered for design.

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

9.	Vol. VI Ch. 8	4 of 5	8.6	Basic wind speed at project site is 39 m/sec. as per IS:875 -1987 Part-3	Clause shall be read as : Basic wind speed at project site is 47 m/sec. as per IS:875 -1987 Part-3
10.	Vol. VI Ch. 11	1 of 19	11.1.1	The Contractor will make his own arrangement (boring, pumping etc.) for withdrawing underground water for construction purpose without any cost implication to the owner. Location of bore hole shall be got approved from the owner / consultant before execution.	Clause shall be read as : The Contractor will make his own arrangement (boring, pumping etc.) for withdrawing underground water for construction purpose without any cost implication to the owner. Location of bore hole shall be got approved from the owner / consultant before execution. Bidder shall obtain Statutory Clearances, as necessary to execute the work.
11.	Vol. VI Ch. 11	1 of 19	11.1.7	A fully equipped quality control laboratory shall be established carried out in presence of OWNER. Finally the laboratory shall be handed over to OWNER in good condition after completion of project.	Clause shall be read as : A fully equipped quality control laboratory shall be established carried out in presence of OWNER. Finally the laboratory (fully equipped with complete set of equipment and accessories) shall be handed over to OWNER in good condition after completion of project.

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

12.	Vol. VI Ch. 11	5 of 19	11.2	Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards.	Clause shall be read as : Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards. Alternatively, wooden wall paneling may also be provided for encasing purpose with necessary protection against fire hazard as per Cl. No. 17.7.9 of Chapter 17.
13.	Vol. VI Ch. 17	13 of 21	17.7.9	All the exposed structural steel Carried out to the satisfaction of the engineer.	Clause shall be read as : All the exposed structural steel Carried out to the satisfaction of the engineer. Alternatively, brick enclosure may also be provided for encasing purpose (refer Cl. No. 11.2 of Chapter 11)
14.	Vol. VI Ch. 23	1 of 3	23.1	Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance. Final approved Plot Plan shall be followed for actual layout of Type-III roads.	Clause shall be read as : Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided all along the inside of the plant boundary for access for security and maintenance. Final approved Plot Plan shall be followed for actual layout of Type-III roads.

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

15.	Vol. VI Ch. 12	15 of 22	12.18	The roof slab and the inside surfaces of the wind shield shall be lined with 20 mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base.	Clause shall be read as : The top exposed surface of roof slab and the inside surfaces of the wind shield above roof slab shall be lined with 20 mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base.
16.	Vol. VI Ch. 9	2 of 23	9.2	The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800 (latest) and other relevant IS standards. For design of coal bins and hopper IS:9178 (Part I to III) shall be followed.	Clause shall be read as : The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800- 1984 and other relevant IS standards. For design of coal bins and hopper IS:9178 (Part I to III) shall be followed.

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

17.	Vol. VI Ch. 9	20 of 23	9.19	Loading tests shall be carried out on erected structures 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 be dismantled and replaced with suitable member. On the basis of the tests, the Engineer will decide and his decision will be final. 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.	Clause shall be read as : 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 as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. 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.
18.	Vol. VI Ch. 13		Header	Ch 13 : IDCT	Header of the Chapter shall be read as : Ch 13 : NDCT

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

19.	Vol. VI Ch. 10	5 of 43	10.7.1 (a) (i)	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 and 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.	Clause shall be read as : Submission of all design calculations, 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 and 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 immediately after the same being approved by Owner / Owner's consultant.
20.	Vol. VI Ch. 11	8 of 19	11.5	RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer refer clause 17.6 also.	Clause shall be read as : RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer.
21.	Vol. VI Ch. 12	6 of 22	12.3.10 (10)	Embedments, if required, to support the stair-case shall be provided in the shell.	Clause shall be read as : Embedments, if required, to connect minor lateral supports of the stair-case shall be provided in the shell.

DEVELOPMENT CONSULTANTS

(AMENDMENT (Civil)_24.07.2015)

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT CIVIL**

22.	Vol. VI Ch. 13,	7 of 25	13.7.1.4	The shell shall also be solar radiation effect. Nevertheless an effective temperature difference of at least 250 C across the shell thickness constant over the height shall be considered.	Clause shall be read as : The shell shall also be solar radiation effect. Nevertheless an effective temperature difference of at least 25 Degree Celsius across the shell thickness constant over the height shall be considered.
23.	Vol. VI Ch. 24	2 of 27	24.2 (p)	p) HDPE liner on the inside slope & bottom of the existing ash dyke is in the scope of Bidder.	p) HDPE liner on the inside slope of raised embankment & top surface of the existing ash pond is in the scope of Bidder.
24.	Vol. VI Ch. 9,	4 of 23	9.4 (e)	e) Chequered plates - 8 mm o/p & above	Clause shall be read as : e) Chequered plates - 6 mm o/p & above
25.	Vol. VI Ch. 2,	4 of 8	2.6 (55)	Minor site grading and leveling to Contractor of this package.	Fairly clear Land on as is where is basis after demolishing existing structures above ground and cutting trees shall be made available to the Contractor. Further work including area grading, Leveling, dressing etc. shall be under scope of the Bidder.

Note: If any clarification issued earlier found contrary to the above amendments, the amendment shall supersede the clarification.

				EPC PACKAGE FOR PANKI THERMAL POWER STATION (1 X 660 MW) BIDDING DOCUMENT NO. : 14A14-SPC-G-0001		
				(L&T Clarifications- Technical - Civil)		
Volumne: VI: Civil						
Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
1	Vol. VI / Civil / Ch. 2	2.6	2 of 8	19. Cooling tower switchgear and MCC	Bidder understands that for NDCT, switchgear and MCC room is not applicable. Please confirm.	Noted.
2	Vol. VI / Civil / Ch. 2 Vol. VI / Civil / Ch. 14	2.6 14.8	4 of 8 9 of 25	54. Paving in coal stock pile area Coal stock yard: Entire area shall be excavated to...Over boulder soling, 75mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 200mm thick RCC slab of grade M20 having double layer reinforcement.	Bidder proposes to provide only 100 mm thick river sand cushion layer over compacted sub grade and consolidated by flooding 150 mm thick boulder soling which shall be laid over sand cushion, joints filled with river sand. Please confirm.	Bidder should strictly follow the requirements of specification
3	Vol. VI / Civil / Ch. 2	2.6	4 of 8	55. Minor site grading and leveling upto 500mm is in the scope of bidder. Finish ground level of entire plant area will be at RL m above Mean Sea Level.	Bidder requests owner to provide RL of the entire plant area.	RL. of plant area shall be decided considering existing contour and other technical requirements.
4	Vol. VI / Civil / Ch. 2	2.6	6 of 8	76. Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the Client. Any infrastructure buried underground shall be demented/relocated by bidder without any additional cost.	Clearing/removal/dismantling/relocation of any underground/buried items is excluded from bidder's scope. Please confirm.	Clearing/removal/dismantling/relocation of any underground/buried items is included in bidder's scope as per specification
5	Vol. VI / Civil / Ch. 2	2.6	6 of 8	76. Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the Client. Any infrastructure buried underground shall be demented/relocated by bidder without any additional cost.	Bidder requests owner to provide details/drawings of all such items. This is required to access quantum of work	Bidder may visit site and collect required data for assessment.
6	Vol. VI / Civil / Ch. 2	2.6	7 of 8	82. (xiv.) Internal/External compound wall is in the scope of bidder	Bidder requests owner to provide specifications/details/cross sectional drawings/routing of internal/external compound wall which is in bidder's scope.	a) For routing of wall refer Plot Plan. Bidder may visit site to collect additional data. b) Details of new wall shall match with existing walls of plant. Bidder may collect the data, if required, by visiting site.
7	Vol. VI / Civil / Ch. 2	2.6	7 of 8	82. (xv.) Site clearance.	All site clearance is excluded in bidder's scope. Bidder understands that site will be handed over to bidder at FGL after all clearance.	Scope of work shall be as per specification.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
72	Vol. VI / Civil / Ch. 12	12.8	11 of 22	32mm dia G.I. drainage spouts shall be provided in the platform for drainage of water.	As there is no drainage requirement for internal platform, Owner to check the applicability of the clause referred here.	Drainage spout shall be provided, if required, as clearly mentioned in specification.
73	Vol. VI / Civil / Ch. 12	12.18	15 of 22	The roof slab and the inside surfaces of the wind shield shall be lined with 20mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base	Bidder understands from referred clause that roof slab top exposed to atmosphere & inside surface of wind shield above roof slab will be lined with 20mm thk acid resistant tiles. Alternatively inside surface of chimney shell above roof slab is provided with acid & heat resistant black bitumen paint without any tiles may also be accepted.	Bidder's understanding is correct. Bidder to follow specification requirements regarding lining.
74	Vol. VI / Civil / Ch. 12	12.10	11 of 22	The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary auxiliary ducting as well as soot collecting hoppers located outside the chimney shell. Soot hoppers shall be lined with SS grade AISI 304. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.	Owner to note that as per routine practice, ash hoppers are located below flue can. Hence, Bidder wants to proceed with same arrangement, Owner to confirm the same. Also, during removal of ash from hoppers, truck entry inside chimney will be required. Hence, the proposed access door of size 2.1x1.00m mentioned under Cl.No. 12.17.b Of chapter 12 of Section VI could be replaced by roll up door of size 4x5m. Owner to confirm.	Specification Cl. No. 12.10 clearly mentions that soot collecting hoppers shall be located below flue can. Specification Cl. No. 12.17(b) clearly mentions that a rolling shutter of size 4m x 5m shall be provided near the base of the windshield at ground level for the purposes of flue can erection ash removal from hoppers.
75	Vol. VI / Civil / Ch. 09	9.7.1	5 of 23	Shear connections shall be designed for 70% of section strength for rolled sections and 80% of section strength of built-up section or rolled section with cover plates.	Bidder requests Owner to confirm that the section strength mentioned in the clause is actually the shear capacity of the section.	Confirmed.
76	Vol. VI / Civil / Ch. 09	9.2	2 of 23	The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800 (latest) and other relevant IS standards.	As specification suggests working stress method of design for steel structures, Owner may please confirm acceptance of the provisions of IS:800 - 1984 as applicable.	Steel structures shall be designed as per provisions of IS:800 - 1984
77	Vol. VI / Civil / Ch. 08	8.2	1 of 5	Imposed loads in different areas shall include live loads, erection, operation and maintenance loads.	Superimposed dead load to be considered for plant building design per the provision 7.2.2 of IS :1893-2004 Part-IV may please be furnished.	The loads are to considered as per equipment specification and load data, which shall be supplied by bidder himself.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
95	Vol. VI / Civil / Ch. 02	2.6 (57)	4 of 8	Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement. Plant boundary wall shall be RCC framed structure consisting of columns and beams at plinth level and top of wall with of Fly Ash Bricks infilled	Owner is requested to furnish the details pertaining to the existing boundary wall which is required to be demolished.	Bidder may please visit site to collect data required for bidding purpose.
96	Vol. VI / Civil / Ch. 02	2.6 (63)	5 of 8	Main gate, time office and security complex – 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 height and 3.0m width shall be provided at the each end. Security complex shall be RCC framed 2 story building. Floor area of this building shall be of minimum 700m sq.	Bidder understand that the floor area of security complex mentioned in the clause is the total floor area of two story building including the security rooms which are required to be provided at each end of the gates. Please confirm.	Confirmed.
97	Vol. VI / Civil / Ch. 04	10)	1 of 3	Architectural floor plans, elevations, cross sections and perspective view in color of all buildings. For main plant building CONTRACTOR shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts.	Owner is requested to furnish the list of the buildings for which the perspective view in color are required.	As per specification. Further details shall be discussed during detail engineering.
98	Vol. VI / Civil / Ch. 10	10.3 (i)	2 of 43	In case of open foundations, loss of contact of foundations (including machine foundations) at founding level shall not be allowed for any combination of loads in the design of any foundation under the scope of this package.	Bidder proposes to allow 25% uplift (loss of contact) for the foundations (excluding machine foundations). Please confirm.	Not allowed. Bidder must adhere to specification requirements.
99	Vol. VI / Civil / Ch. 10	10.7.1 (a) ((i))	5 of 43	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 and 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.	Bidder understands that the AUTOCAD copy of the drawings are required to be submitted as "AS BUILT" only. Please confirm.	AUTOCAD version of all civil, structural and architectural drawings shall be submitted after the same being approved by Owner/Owner's Consultant. Cl. No. 4.0 (30) in Chapter 04 of specification shall also be referred in this regard.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
100	Vol. VI / Civil / Ch. 10	10.1	5 of 43	Minimum Diameter of the Reinforcement	8 mm dia. reinforcement may please be allowed for stirrups, slab and also as main/distribution rebar in various misc. structures like Slab, Trenches. Please confirm.	Bidder to follow specification requirements.
101	Vol. VI / Civil / Ch. 11	11.5	8 of 19	RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer refer clause 17.6 also. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.	Bidder understands that the clause no. 17.6 (Landscaping) is not applicable along with this clause. Please confirm.	Confirmed.
102	Vol. VI / Civil / Ch. 11	11.9	9 of 19	Foundation system for CW pump House shall be designed carefully keeping in view the nature of soil. For CW forebay structure (only) PRV can be used to relieve uplift water pressure on the base slab. In this case, base slab of the CW forebay shall be designed for 50% of water uplift pressure. CW forebay shall be open at top and galvanized MS handrails shall be provided all round the CW forebay.	Bidder understands that the CW channel connected to the CW forebay is open at top in line with CW forebay . Please confirm.	As per specification and system design requirement. Further details shall be discussed during detail engineering.
103	Vol. VI / Civil / Ch. 11	11.12.3	12 of 19	Parking sheds (for both four wheelers and two wheelers) shall be provided at service building, security complex, at CW pump house area etc., at all locations for operating staff. The parking sheds shall be of RCC.	Owner is requested to kindly furnish the area wise vehicle numbers (i.e. nos. of two and four wheelers) for the parking sheds.	Bidder to consider requirement of 660 MW unit. Further detail shall be shall be reviewed during detail engineering.
104	Vol. VI / Civil / Ch. 11	11.12.4	12 of 19	Workshop	Owner is requested to kindly furnish the minimum floor plan area requirement to be considered for the workshop.	Adequate information is available in specification. Bidder to consider size as per the requirement.
105	Vol. VI / Civil / Ch. 11	11.14	14 of 19	Fuel oil Handling System	Owner is requested to furnish the bitumen grade for the sand mixture which is required to be laid over the confined river sand beading for the fuel oil storage tank foundations.	During detail engineering.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
15	Vol. VI / Civil / Ch. 2	2.6	2 of 8	16. Construction / modification of RCC pedestals for supporting Ash disposal pipes, ash water recirculation pipe and bottom ash slurry pipes upto existing ash dyke including garlanding.	Bidder requests owner to provide details of existing pedestals for ash disposal pipes, ash water recirculation pipe and bottom ash slurry pipes upto existing ash dyke including garlanding.	Bidder may visit site to collect data required during bidding stage. Detail drawings shall be furnished to successful bidder during execution of this package.
16	Vol. VI / Civil / Ch. 24	24	1 of 27	Raising and strengthening of existing ash dyke.	Specification related to raising and strengthening of existing ash dyke is given but same is not mentioned in scope under Vol VI, Ch. 02. Please clarify.	Raising and strengthening of existing ash dyke is in bidder's scope. Bidder may refer Cl. No. 15.1 of specification in this regard.
17	Vol. VI / Civil / Ch. 24	24	1 of 27	Raising and strengthening of existing ash dyke.	If same is in bidder's scope, bidder requests owner to provide drawings/cross section details of existing ash dyke.	Detail shall be furnished to successful bidder during execution stage.
18	Vol. VI / Civil / Ch. 24	24	1 of 27	Raising and strengthening of existing ash dyke.	Bidder requests owner to provide Geotechnical report, stability analysis report of existing ash dyke.	Detail shall be furnished to successful bidder during execution stage.
19	Vol. VI / Civil / Ch. 2	2.6	4 of 8	55. Minor site grading and leveling upto 500mm is in the scope of bidder.	Bidder requests owner to provide topographical survey drawing of NGL/OGL.	Available contour drawing is attached.
20	Vol. VI / Civil / Ch. 2	5	1 of 4	Geo Technical Investigation	Bidder requests owner to provide geotechnical investigation report for the proposed site.	Shall be provided shortly.
21	Vol. VI / Civil / Ch. 2	5	1 of 4	Geo Technical Investigation	Bidder requests owner to provide borehole location report for the proposed site.	Shall be provided shortly.
22	Vol. VI / Civil / Ch. 2	2.6	4 of 8	57. Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement.	Please provide details/drawings/length of existing compound wall which is to be demolished.	Bidder may visit site to collect data required during bidding stage. Details shall be furnished to successful bidder during execution of this package.
23	Vol. VI / Civil / Ch. 2	2.6	4 of 8	57. Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement.	Bidder understands that overall height of boundary wall shall be 3mt from corresponding FGL. Please confirm.	Detail of boundary wall shall match with the existing one. Bidder may please visit site to collect data.
24	Vol. VI / Civil / Ch. 11	11.1.9	2 of 19	Contractor to establish a Fly Ash Brick Plant at site to fulfil the requirement of Fly Ash Bricks for the project.	Bidder understands that required quantity of fly ash shall be provided free of cost by the Owner. Please confirm.	Fly ash as available shall be provided.
25	Vol. VI / Civil / Ch. 11	11.9	9 of 19	For CW forebay structure (only) PRV can be used to relieve uplift water pressure on the base slab.	Bidder requests to allow PRV for CW forebay and CW channel structure to relieve uplift water pressure on the base slab. Please confirm.	Use of PRV is only allowed in CW forebay basin satisfying requirements laid down in Cl. No. 11.9 of specification. PRV is not allowed in channel.
26	Vol. VI / Civil / Ch. 11	11.9	8 of 19	CW Forebay & Channel	CW forebay and channel shall be open at top and Galvanized MS handrails shall be provided all around. Please confirm.	Confirmed.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
34	Vol. VI / Civil / Ch. 16	16.1	2 of 2	The DM plant building will be RCC framed building having brickwork cladding on all four sides.	Bidder shall be given choice of RCC framed building or RCC framed building with steel truss supporting RCC roof with metal deck sheet.	Bidder should adhere to specification requirements.
35	Vol. VI / Civil / Ch. 17	17.2 (v)	2 of 21	All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736 treated with primer and finished with suitable paint.	As per mentioned clause, handrails pipe dia shall be 50mm NB (Except at operating floors) whereas as per clause Ch. 06, 6.8, page 3 of 11, all handrails shall be of 32mm NB. Bidder understands that clause Ch. 06, 6.8 page 3 of 11 shall prevail i.e. all handrails shall be of 32mm NB. Please confirm.	32 NB.
36	Vol. VI / Civil / Ch. 17	17.2 (v)	2 of 21	All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.	All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB MS Galvanized pipes may please be accepted.	Ok.
37	Vol. VI / Civil / Ch. 17	17.7.1 (b) (i)	5 of 21	Outside plaster on masonry wall: no plastering is required on outside of masonry wall. Since outside surface of brick wall will be exposed, contractor to manufacture good shape bricks to suit the exposed brick work. Silicone coating shall be provided on outside exposed face of brick wall.	Bidder suggests to provide 18 mm thick water proof plaster in two layers on outside surface of masonry in cement mortar 1:6 with suitable proportion of integral water proofing compound in place of exposed brickwork with silicone coating. Please confirm.	Bidder to follow specification.
38	Vol. VI / Civil / Ch. 17	17.7.1 (b) (i)	5 of 21	Outside plaster on masonry wall: no plastering is required on outside of masonry wall. Since outside surface of brick wall will be exposed, contractor to manufacture good shape bricks to suit the exposed brick work. Silicone coating shall be provided on outside exposed face of brick wall.	Bidder requests Owner to provide: 1. List of buildings where exposed brickwork is required. 2. For exposed brickwork please clarify ash brick or red brick should be considered.	Bidder to follow specification.
39	Vol. VI / Civil / Ch. 17	17.7.4 (a)	8 of 21	To suit the spacing of purlin, the length of sheet may vary between 1.50 to 2.00 m.	Bidder requests to accept the length of sheet as per manufacturer standard.	Bidder to follow specification.
40	Vol. VI / Civil / Ch. 19	19.1	1 of 1	Necessary grids shall be made by EPC contractor including demarcating the structures, buildings and jungle clearance including Cutting, uprooting and removing of trees and dispose the same away from the site etc.	Bidder understands that tree cutting/jungle clearance, uprooting and disposal of the same are not in Bidder's scope including necessary permission from statutory authorities need to be arranged by Owner. Please confirm.	Tree cutting/jungle clearance, uprooting and disposal of the same are not in Bidder's scope. Obtaining necessary permission from statutory authorities is in Bidder's scope. Owner shall assist Bidder in this regard.
41	Vol. VI / Civil / Ch. 20	20.3	1 of 4	Borrow materials for back- filling shall be excavated from approved locations.	Identification of borrow area, acquisition & right of way shall be in Owner's scope. The distance from plant boundary shall not be more than 5 km. Please confirm.	It will be in Bidder's scope. Bidder should visit for appraisal.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
50	Vol. VI / Civil / Ch. 02	2.6	2 of 6	22. A raw water pump house (intake structure) to be constructed inside plant boundary near the Lower Ganga Canal to pump the make-up water through MS pipes to Raw Water reservoir.	Bidder requests owner to provide layout of raw water pump house intake structure to be constructed near the lower ganga canal.	For location refer Plot plan. Other relevant details, if any, shall be furnished to successful bidder during execution stage.
51	Vol. VI / Civil / Ch. 02	2.6	2 of 6	22. Diversion and reconstruction to original width and alignment of existing road outside plant boundary is also included in Bidder's scope.	Bidder requests owner to provide details of existing road which is to be diverted and reconstructed.	Bidder may please visit site to collect necessary data for bidding purpose.
52	Vol. VI / Civil / Ch. 06	6.15	9 of 11	Watch Tower shall be constructed with RCC frame work.	Bidder shall be given a choice of RCC sub structure with Steel frame work super structure.	Bidder to follow specification requirements.
53	Vol. VI / Civil / Ch. 08 Vol. VI / Civil / Ch. 12	8.6 12.3.7	4 of 5 3 of 22	Basic wind speed at project site is 39 m/sec. as per IS:875 -1987 Part-3 Basic wind speed = 47 m/s (upto 10m above normal ground level) as per IS:875 (Part-3) : 1987.	Both clauses are contradictory. As per IS: 875 Part-3: 1987, basic wind speed at project site is 47m/sec. Owner is requested to clarify.	basic wind speed shall be 47 m/s as per IS:875 (Part3)-1987.
54	Vol. VI / Civil / Ch. 10	10.11.1	12 of 43	All wall beams shall be provided with gunniting of 50 mm thick around with nominal reinforcement and chicken mesh.	Bidder may please be given a choice to encase all wall beam with brickwork - anchored with MS Bar/Flat and covered allround with chicken mesh for plaster.	Bidder to follow specification requirements. Deviation not allowed.
55	Vol. VI / Civil / Ch. 10	10.12	12 of 43	Construction joints at the following two (2) locations shall be provided:	Bidder requests to finalize location and number of construction joints during detailed engineering as per bidder's OEM standard.	Bidder to follow specification requirements.
56	Vol. VI / Civil / Ch. 11	11.1.1	1 of 17	Construction water: The Contractor will make his own arrangement (boring, pumping etc.) for withdrawing under ground water for construction purpose without any cost implication to the Owner. Location of bore hole shall be got approved from the Owner / consultant before execution.	Statutory clearance required for drawl of ground water for purpose of construction/drinking shall be arranged by Owner. Please confirm Bidder's understanding.	Obtaining statutory clearance is Bidder's scope.
57	Vol. VI / Civil / Ch. 11	11.1.7	2 of 19	Quality control laboratory: Finally the laboratory shall be handed over to Owner in good condition after completion of project.	Bidder understands that quality control laboratory shall be handed over without equipment. Please confirm. However, the location of the quality control laboratory shall be decided by the Bidder.	The laboratory shall be fully equipped.

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of clarification sought	Owner's Reply
65	Vol. VI / Civil / Ch. 23	23.1	1 of 2	Type III roads shall be provided along the plant boundary for access for security and maintenance.	As per plot plan, no road is shown along the plant boundary inside the plant area. Please confirm the requirement of Type III roads.	Type-III road shall be provided all along the inside of the plant boundary. A 4.0m wide road shall also be provided all along the outside of the boundary wall of the project as per Cl. 23.1 of specification.
66	Vol. VI / Civil / Ch. 02	2.6	7 of 8	82. (xiii.) Green belt development	Bidder requests owner to provide area which is to be developed as green belt under bidder's scope of work.	Green belt to be developed as per statutory requirements.
67	Vol. VI / Civil / Ch. 8	8.5	4 of 5	Seismic analysis shall be carried out as per the latest edition of IS:1893 (Part 1 & 4). Zone-IV shall be considered for design.	As per IS: 1893, project site falls under Zone III. Bidder requests owner to clarify.	Seismic Zone - III shall be considered.
68	Vol. VI / Civil / Ch. 24	24	1 of 27	Raising and Strengthening of Ash Dyke	Owner is requested to furnish detail design drawings of existing ash dyke.	Bidder may visit site to collect data required during bidding stage. Details shall be furnished to successful bidder during execution of this package.
69	Vol. VI / Civil / Ch. 24	24.2.n	2 of 27	RCC collector wells with steel approach bridges.	Owner is requested to furnish the detail drawings of collector well system in the existing ash dyke.	Bidder may visit site to collect data required during bidding stage. Details shall be furnished to successful bidder during execution of this package.
70	Vol. VI / Civil / Ch. 24	24.18	13 of 27	Laying of jute geo-textile 500 GSM with aperture size 100mmx100mm on the downstream slopes of ash dyke to be held in position by wooden pegs/8mm dia MS bars at 3 meter center to center followed by providing and spreading, seedlings of grass, watering etc. complete till the grass establishes itself uniformly.	Owner is requested to confirm whether it is mandatory to provide geotextile on downstream slope.	Bidder to follow specification requirements.
71	Vol. VI / Civil / Ch. 12	12.6.b	9 of 22	Load Bearing & Side Restraint of Flues	Bidder's preference is to use structurally built up flue support & lateral restraint assembly. This being a manufacturer's standard, owner is requested to accept it as an alternative.	Bidder to follow specification requirements.



1 x 660 MW - Panki Thermal Power Station

TECHNICAL AMENDMENT NO.-2

5.	Volume-III Ch.5	1 of 15	5.1	The source of raw water is upper Ganga Canal.	The source of raw water is lower Ganga Canal.
6.	Volume-III Ch.13	1 of 3	13.1	Minimum capacity of rain water harvesting pond shall be 50,000 cum and that shall be in the construction yard area surrounded by landscaped garden.	Minimum capacity of rain water harvesting pond shall be 50,000 cum and that shall be in the construction yard area surrounded by landscaped garden. Bidder shall quote bid price considering rain water harvesting capacity of 50,000 cum as per specification. However, bidder shall quote the take out price of civil construction of (a) 50,000 cum Rain Water Harvesting Pond, (b) 20,000 cum Rain Water Harvesting Pond in Schedule-9, Section VI, Book 2 of 3, Volume.-I.
7.	Volume-III Ch.13	1 of 3	13.1		Two nos. Working and one no. Standby (2W+1S) pumps shall be considered for Rain Water Harvesting.
8.	Volume-III Ch.19	12 of 116	1.3 Sl. No. 3	Each Tippler shall operate its rated capacity of 20 tips per hour. It shall be capable of safely unloading Twenty (20) numbers of Wagons per hour on a continuous basis Including hauling, pause, decoupling and weighing time etc in conjunction with side arm charger.	Each Tippler shall operate its rated capacity of 25 tips per hour. It shall be capable of safely unloading Twenty five (25) numbers of Wagons per hour on a continuous basis Including hauling, pause, decoupling and weighing time etc in conjunction with side arm charger.
9.	Volume-III Ch.19	1 of 116	1.1.3	Conveyor stream capacity :	Conveyor stream capacity : 1500 TPH rated, 1650 TPH design

**1 X 660 MW Panki Extension Thermal Power Project****AMENDMENT-4 (Civil & Architectural)**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
1	VOL-VI Ch. 02	5 of 8	2.6 (63)	Training center	Training centre shall be consists of minimum following requirement: a) Total area = 250 Sqm-Single storey RCC building. b) One AC Conference room for of size =90 Sqm. c) One reception of = 20 Sqm (AC area) d) One Hall for library = 50 Sqm. (AC area) e) Office Room & faculty room = 30Sqm (AC area) - f)Toilets for Ladies & Gents = 20Sqm g) Pantry = 8 sqm h) Utility area = 12 Sqm i) A Porch of size 5m x 4m will be provided. j) 2 numbers class rooms of 30 students each including the following details. The finishing of walls, floor, and other specification shall be similar to Service building

**1 X 660 MW Panki Extension Thermal Power Project****AMENDMENT-4 (Civil & Architectural)**

2.	VOL-VI Ch. 02	6 of 8	2.6 (72)	Dispensary and first aid center	Minimum size of Dispensary & first aid center shall be 14m (length) x 12m (width) x 4m (Height).
3.	Vol VI Ch 2	5 of 8	63. Auxiliary Building	Security complex shall be RCC framed 2 storey building. Floor area of this building shall be of minimum 700m sq.....	 Security complex shall be RCC framed 2 storey building. Floor area of this building shall be of minimum 700m sq..... ● Service Building, Administration Building & Training Centre Building shall be designed with ECBC code and other relevant code/standard to make it “Green Building” .

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
1.	Vol. VI, Chapter 2	4 of 8	2.6 (57)	Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement. Plant boundary wall shall be RCC framed structure consisting of columns and beams at plinth level and top of wall with of Fly Ash Bricks infilled	Plant boundary : Nature and extent of work shall be as per description given in drawing no. 14A14-DWG-M-046 attached with this Amendment. The work shall include demolition of existing boundary wall including foundation and fencing as well as construction of new boundary wall and fencing in designated areas/stretches as mentioned in drawing no. 14A14-DWG-M-046. Bidder should note that tentative stretches of different types of work are furnished in the drawing mentioned above and nothing extra shall be payable in case of variation in stretch/length of any type of work w.r.t. those shown in the drawing are found during detail engineering. Bidder may pay a visit to site, if desired, to have clear understanding about the extent of work in this regard. Boundary wall shall be RCC framed structure with fly ash full brick in-fill panels. Minimum height of wall (excluding concertina) from existing ground level outside plant boundary shall be 3.0m. RCC columns with foundation at a maximum spacing of 3.0m and RCC grade beam (having top at ground level) between columns shall be provided. RCC beam at top of wall shall also be provided between columns. Debris obtained from demolition work shall be removed and stacked in designated areas identified

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
					by Owner during execution. Boundary wall shall be plastered on both sides with decorative waterproof painting. The cast-in-situ RCC columns shall have decorative precast heads. Plant's logo shall be used in each panel in between two concrete columns. Special textured paint shall be applied to a suitable location of the boundary wall to enhance the entrances. RCC columns shall have M. S. angle 'Y' support for 600mm high barbed wire fencing (7 strands) and 600mm diameter RBT concertina coil on top of the boundary wall. Fencing shall be provided as per the details described elsewhere in the specification and Amendments issued earlier.
2.	Vol. VI, Chapter 2	7 of 8	2.6 (82) (xiv)	Internal/External compound wall is in the scope of bidder.	Internal/External compound wall, as marked in drawing no. 14A14-DWG-M-046 is in the scope of bidder.
3.	Vol. VI, Chapter 14	9 of 25	14.8	Entire area shall be excavated to average 300mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be	Entire area shall be excavated to suitable depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				movement and shall be designed to sustains coal water pressure.	
4.	Vol. VI, Chapter 23	1 of 2	23.1	Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance. Final approved Plot Plan shall be followed for actual layout of Type-III roads. A 4.0 m wide RCC road with 1m shoulder on both sides shall be build/constructed all along the outside of the boundary wall of the plant.	Type III roads shall be of R.C.C & 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance. Final approved Plot Plan shall be followed for actual layout of Type-III roads. A 4.0 m wide RCC road with 1m shoulder on both sides shall be build/constructed all along the outside of the boundary wall of the plant. For further details refer drawing no. 14A14-DWG-M-046 attached with this Amendment.
5.	Vol. VI, Chapter 10	29 of 43	10.21	The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 500 conforming to IS:1786 – latest.	The reinforcement used shall be high strength deformed TMT bars of grade Fe 500 conforming to IS:1786 – latest.
6.	Vol. VI, Chapter 23	1 of 3	23.1	A 4.0 m wide RCC road with 1m shoulder on both sides shall be bild/constructed all along the outside of the boundary wall of the plant.	A 4.0 m wide RCC road with 1m shoulder on both sides shall be build/constructed along the outside of the boundary wall of the plant as mentioned in drawing no. 14A14-DWG-M-046 attached with this Amendment.



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
7.	AMENDMENT-1 (CIVIL)	8 of 8	Sl. No. 23	p) HDPE liner on the inside slope of raised embankment & top surface of the existing ash pond is in the scope of the Bidder.	p) HDPE liner on the inside slope of raised embankment & top surface of the existing ash pond is in the scope of the Bidder. Minimum thickness of HDPE liner shall be 1 mm.
8.	Vol. VI, Chapter 24	1 of 27	24.2 (d)	Protective jute geo-textile 500 GSM with aperture of 100x 100 mm /grass turving on the outside face of the embankment.	Protective jute geo-textile 500 GSM with aperture of 100x 100 mm and grass turving on the outside face of the embankment.
9.	Vol. VI, Chapter 02	5 of 8	2.6 (63)	Main gate, time office and security complex – 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 height and 3.0m width shall be provided at the each end. Security complex shall be RCC framed 2 storey building. Floor area of this building shall be of minimum 700m sq.	Main gate, time office and security complex – 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 height and 3.0m width shall be provided at the each end. CISF facilities shall also to be accommodated within this building. Security complex shall be RCC framed 2 storey building. Floor area of this building shall be of minimum 800 sqm.
10.	Vol. VI, Chapter 02	5 of 8	2.6 (63)	Auxiliary Building	Add following buildings/structures : • Diesel Pump Shed for locomotives, dozers,



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
					cars etc. • Watch Towers Diesel Pump Shed shall be steel framed structure with brick wall up to window sill height and insulated double skin metal sheet cladding above it. Roof of the shed shall be insulated double skin metal sheeting on steel roof truss. The building shall provide adequate space for all functional requirements including office rooms, stores, toilet and pantry etc. Minimum size of this shed shall be 500 sqm. External finish for brick walls shall be of premium acrylic smooth paint. Door window and other internal finishes shall be as per the details of other pump houses described elsewhere in the specification and Amendments issued earlier.
11.	Vol. VI, Chapter 06	9 of 11	6.15	Watch Tower shall be constructed with RCC frame work. Floor of tower shall be at least 6m above graded level. Covered area for each tower shall be approx. 25 sqm. Number of towers shall be such that the complete periphery of the plant can be watched from the towers but in no case the number of towers shall be less than twelve.	Watch Tower shall be constructed with RCC frame work. Floor of tower shall be at least 6m above graded level. Covered area for each tower shall be approx. 25 sqm. Locations of towers shall be such that the complete periphery of the plant can be watched from the towers but in no case the number of towers shall be less than those shown in drawing no. 14A14-



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
					DWG-M-046 attached with this Amendment. 1m wide watch balcony around the tower shall be provided at floor level. Steel stair shall be provided to access the floor. Full length vision window on every side shall be provided. Hollow metal pressed steel doors shall be used. Windows shall be Aluminium/steel windows with 4mm thick clear float glass. Balcony railing height shall be 1200mm.
12.	Vol. VI, Chapter 07	1 of 1	7.1	Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 8 mm O/P.	Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 6 mm O/P.
13.	Vol. VI, Chapter 02	1 of 8	2.6	5. Foundation for steam generator / ESP / duct supporting structure.	5. Foundation for steam generator (including future installation of SCR), ESP, duct supporting structure.
14.	Vol. VI, Chapter 12	3 of 22	12.3.4	Flue gas temperature at inlet / exit 127°C (approx.)	Flue gas temperature at inlet / exit without FGD in operation shall be 127°C (approx.). During operation of FGD the temperature of flue gas at chimney inlet shall be 80deg C or lower.
15.	Vol. VI, Chapter 12	4 of 22	12.3.10	The heat insulation of the liners and pressurized ventilation system shall be so designed that temperature in annular space between the chimney shell and flues does not exceed 45 Deg.C in peak	The heat insulation, if required, at the outside face of the liners and ventilation system (as required) shall be so designed that temperature in annular space between the chimney shell and flues does not



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				summers.	exceed 45 Deg.C in peak summers.
16.	Vol. VI, Chapter 12	7 of 22	12.5.1	General Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting structure. The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. The liner shall be supported atleast at five different levels, and restrained laterally at several levels, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between. The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be	General Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation, if required. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting structure. The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. Acid resistant Boro Silicate brick lining shall be provided at inside face of the flue. The liner shall be supported at least at five different levels, and restrained laterally at several levels, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between. The structural steel transition inlet ducting shall be



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion compensator. Clean-out door shall be provided below the flue for removal of ash.	bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion compensator. The transition ducting connecting the chimney inlet duct and flue shall be fabricated with steel S-TEN 1 . Clean-out door shall be provided below the flue for removal of ash.
17.	Vol. VI, Chapter 12	8 of 22	12.6 Insulation	(a) On exterior surface of flue. The flue shall be insulated externally. 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 100 kg/cum for resin bonded rock wool. The coefficient thermal conductivity of insulation shall be 0.52mW / cm/^o c at a mean temperature of 100°C. Insulation / wrapping over fluecan shall be done at ground level before erection. The insulation thickness shall be determined based on the maximum ambient temperature, surface air	(a) On exterior surface of flue. The flue shall be insulated externally, if required. The external insulation of the steel flue liners shall be provided, if necessary, considering the temperature profile through the wall of the flue to ensure the exposed surface temperature of borosilicate brick lining is maintained within acceptable limits (over the full range of operating conditions including possible temperature excursions during FGD bypass operation). 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

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				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 60°C. The draught of air in the annular space shall be the natural draught 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. However, a minimum of 50 mm thick (2 layers of 25 mm) insulation shall be provided on the external face of flue. The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450mm c/c both horizontally and vertically. The studs shall be galvanized plated and be of a minimum thickness of 10 gauge and 75 mm wide. The studs shall extend a minimum of 25 mm beyond the thickness of insulation. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanized wire mesh with a 25	be less than 100 kg/cum for resin bonded rock wool. The coefficient of thermal conductivity of insulation shall be 0.52mW/cm/°C at a mean temperature of 100°C. Insulation / wrapping over flue can shall be done at ground level before erection. 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 60°C. The draught of air in the annular space shall be the natural draught 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. However, insulation where provided within windshield shall be in double layers as minimum. The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450mm c/c both horizontally and vertically. The studs shall be

**1 x 660 MW - Panki Thermal Power Station****AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)**

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centers. Any form of lacing the mesh fibres together will not be permitted. Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. This shall be protected from the elements by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel. Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings by the contractor shall be carried out. Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound	galvanized plated and be of a minimum thickness of 10 gauge and 75 mm wide. The studs shall extend a minimum of 25 mm beyond the thickness of insulation. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanized wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centers. Any form of lacing the mesh fibres together will not be permitted. Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. This shall be protected from the elements by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel. Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall noise Reduction Coefficient shall be 0.80 or better.	by the contractor shall be carried out. Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall noise Reduction Coefficient shall be 0.80 or better.
18.	Vol. VI, Chapter 12	11 of 22	12.10	Design of Transition Ducting The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and provision of restraint / support arrangement as required. The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary	Design of Transition Ducting The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and provision of restraint / support arrangement as required. The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				auxiliary ducting as well as soot collecting hoppers located below flue can. Soot hoppers shall be lined with SS grade AISI 304. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water. The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimize flue gas pressure losses. The plate thickness of the ducts shall be arrived at from minimum (i.e. codal) requirements, structural considerations and corrosion allowances. Material of construction shall be COR-TEN steel conforming to IS:2062. Minimum thickness shall be 10 mm. The duct work shall be insulated with 75 mm thick insulation (3 layers of 25 thick sheets) as per requirements of clause 18.11 and protected with aluminium foil of minimum 1mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning. The duct work and its supporting structures shall be	necessary auxiliary ducting as well as soot collecting hoppers located below flue can. Inside face of Soot hoppers shall be lined with Acid resistant Boro Silicate brick. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water. The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimize flue gas pressure losses. The plate thickness of the ducts and hopper shall be arrived at from minimum (i.e. codal) requirements, structural considerations and corrosion allowances. Material of construction shall be S-TEN 1 steel. Minimum thickness shall be 10 mm. The duct work shall be insulated with 75 mm thick insulation (3 layers of 25 thick sheets) and protected with aluminium foil of minimum 1mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning. The duct work and its supporting structures shall be



1 x 660 MW - Panki Thermal Power Station

AMENDMENT-5 (CIVIL, STRUCTURAL & ARCHITECTURAL)

Sl. No.	Volume / Chapter	Page No.	Clause No.	Bid Specification	AMENDMENT
				designed for the most severe of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, wind loading, flue gas pressure loading and thermal loading.	designed for the most severe of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, wind loading, flue gas pressure loading and thermal loading.

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UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)

TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	OWNER'S REPLY
	Vol / Sec	Sub Sec	Page No.	Clause No.			
73.	VOL-VI/ CHAP- TER 02	Scope of Civil & Structural Works	5 of 8	2.6 (63)	Training center.	Since the Training centres is non plant building and the layout of Training centre depends on customer requirement, customer is requested to inform the size of building to be considered by all bidders for estimation. In absence of data regarding covered area & floor details etc. in specification. Bidder considered following for Training centre. a) Total area = 250 Sqm-Single storey RCC building. b) One AC Conference room for of size =90 Sqm. c) One reception of = 20 Sqm (AC area) d) One Hall for library = 50 Sqm. (AC area) e) Office Room & faculty room = 30Sqm (AC area) f) Toilets for Ladies & Gents = 20Sqm g) Pantry = 8 sqm h) Utility area = 12 Sqm i) A Porch of size 5m x 4m will be provided. The finishing of walls, floor, and other specification shall be similar to Service building. No Furniture, furnishing, office equipment, partition/paneling for office, etc. is considered in the scope of bidder. Customer is requested to issue suitable amendment or confirm the size considered.	Additionally bidder should consider at least 2 numbers class rooms of 30 students each including the following details.



UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)

TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	
	Vol / Sec	Sub Sec	Page No.	Clause No.			OWNER'S REPLY
77.	VOL-III/ CHAP- TER -25	Air Condi- tioning & Venti- lation System	4 of 40	25.3.19	Air conditioning system for Service Building, Adminis- tration Building & Training Centre Building shall be designed with ECBC code to make it "Green Building".	Customer is requested to clarify the follow- ing: A. As per tender specification Only Air conditioning system for Service Building, Administration Building & Training Centre Building shall be de- signed with ECBC code or B. Service Building, Administration Building & Training Centre Building shall be designed with ECBC code to make it green building. If so cus- tomer is requested to inform the GRIHA rating or only Customer is requested to issue suitable amendment in case B is to be followed	Bidder to follow specification.



UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)

TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	
	Vol / Sec	Sub Sec	Page No.	Clause No.			OWNER'S REPLY
78.	VOL-VI/ CHAP- TER 02	Scope of Civil & Struc- tural Works	6 of 8	72.0	Dispensary and first aid center.	Since the dispensary and first aid centres are non-plant buildings, customer is requested to inform the size of building to be considered by all bidders for estimation. In absence of size we have considered the size of Dispensary Bldg. has been considered as below 14m (length) x 12m (width) x 4m (Height). Customer is requested to issue suitable amendment or confirm the size considered..	Noted
79.	VOL-VI/ CHAP- TER -07	Material	1 of 1	7.1	Complete hopper including vertical and conical portion of the bunker in mill building shall be provided with lining of at least 6mm thick SS plate grade SS 316L	SS 304 provides better finish profile inside bunker. Bending and stitching of plate inside bunker with higher thickness of plate (6mm) is very difficult, and technically not required. To reduce the friction inside conical hopper with SS 304 plate of thickness 3.15mm is having excellent advantage. Bidder advice to use SS plate in hopper portion only, and it is also the current practice in case of circular bunker design. Customer is requested to review the requirement and confirm acceptance.	Bidder should strictly follow Specification.



UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)

TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	OWNER'S REPLY
	Vol / Sec	Sub Sec	Page No.	Clause No.			
88.	VOL-VI/ CHAP- TER - 2	Scope of work	2 of 8	2.6 (14)	Modification (if required) of existing return channel...	Length, location & layout of return channel is not clear as per Plot Plan. Therefore, no length has been considered for dismantling/construction. Kindly Accept.	Modification (if required) of existing return channel shall be under scope of this package. Bidder should assess the quantum of work and follow specification.
89.	VOL-VI/ CHAP- TER - 13	Civil Design Basis	6 of 25	13.7.1.2	For coefficient 'K2', Terrain category '1' and class 'C' as per table 2 of IS: 875 (Part-3) – 1987 (Latest) shall be considered.	As per site condition/location & IS: 875 (Part-3), Terrain category '2' shall be considered for proposed plant including cooling tower & chimney. Please accept.	Bidder should follow Specification.
90.	VOL-VI/ CHAP- TER - 21	Water closet	11 of 12	21.9 g.)	One toilet with required facilities shall be provided for physically challenged persons as per National Code requirements in GRIHA rated buildings.	As per Specification there is no GRIHA rated building, however one toilet for physically challenged persons shall be provided as per this clause.	Noted. Also note that Administrative Building shall be designed as GREEN Building.
91.	DWG NO.14A 14-DWG-M-001	PLOT PLAN			Plot Plan (Item No.-43)	In the Plot plan township has been marked. As per specification bidder understand that township construction is not in bidder's scope. Please confirm.	Noted

 Larsen & Toubro Limited EPC Power Business Unit		EPC PACKAGE FOR PANKI THERMAL POWER STATION (1 X 660 MW) BIDDING DOCUMENT NO. : 14A14-SPC-G-0001				
		TECHNICAL DEVIATION / CLARIFICATION				
Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of Deviations / Variations / Exceptions/Clarification	Owner's Reply
2.16 Civil Deviations						
1	Vol-II Chapter-2	1.13	1 OF 7	Amendment 1 to TS: Station Graded Level Elevation from Mean Sea Level (MSL) : Plant FGL : ● Plant FFL : Plant FGL+0.500M– EI (+/-	With reference to additional clarifications to queries raised by one of the bidders vide e-mail dated 16.07.2015, UPRVUNL's reply on Sr. No. 9 query, HFL mentioned is RL (+) 124.827m. Based on this data, bidder will consider FGL as RL (+) 125.500 m.	PI refer to UPRVUNL response to bidder (BHEL) Query vide no 2208 dt 09.09.2015. However this shall be finalised during detail engineering on survey to be done by EPC contractor.
2	Ch. 10	10.12	12 of 43	The number of construction joints in the columns of steam turbine foundation shall be restricted.	Bidder will consider Location and number of construction joints based on bidder's standard practice and construction point of view. This practice is widely accepted in similar power projects of NTPC and SEBs.	Bidder should strictly follow stipulations of specification. Location of additional construction joints, if required, shall be decided during detail
3	Vol. VI / Civil / Ch. 2	2.6	7 of 8 4 of 8	82. (xiv.) Internal/External compound wall is in the scope of bidder 57. Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site requirement.	Bidder's PBQ: Bidder requests owner to provide specifications/details/cross sectional drawings/routing of internal/external compound wall which is in bidder's scope. UPRVUNL reply: a) For routing of wall refer Plot Plan. Bidder may visit site to collect additional data. b) Details of new wall shall match with existing walls of plant. Bidder may collect the data, if required, by visiting site Bidder's clarification: Bidder had been to site in order to collect data pertaining to existing compound walls of plant, However, no information could be collected from the site office. Bidder requests owner to provide the existing compound drawings/layout to assess quantum of work. Also, please provide layout/drawings for new boundary wall to be constructed.	Data, if available with UPRVUNL, shall be furnished to bidder during detail engineering.

 Larsen & Toubro Limited EPC Power Business Unit		EPC PACKAGE FOR PANKI THERMAL POWER STATION (1 X 660 MW) BIDDING DOCUMENT NO. : 14A14-SPC-G-0001				
		TECHNICAL DEVIATION / CLARIFICATION				
Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of Deviations / Variations / Exceptions/Clarification	Owner's Reply
2.16 Civil Deviations						
7	Vol. VI / Civil / Ch. 2	2.6	2 of 6	22. Diversion and reconstruction to original width and alignment of existing road outside plant boundary is also included in Bidder's scope.	Bidder's PBQ: Bidder requests owner to provide details of existing road which is to be diverted and reconstructed. UPRVUNL reply: Bidder may please visit site to collect necessary data for bidding purpose. Bidder's clarification: Bidder had been to site in order to collect data pertaining to existing roads of plant, however, Bidder could not obtain any necessary data/drawings pertaining to diversion and reconstruction to original width and alignment of existing road outside plant boundary from the site office. Hence bidder will not consider the same in his scope.	Scope of work should strictly be as per specification. Bidder must assess the quantum of work.
8	Volume VI Ch 2	2 of 8	24	Raw water reservoir (storage capacity of 10 days without ash water recovery) for running of 1x660MW unit during canal closing period is in the scope of bidder.	Bidder understands that as per tender WBD, tentative water requirement will be about 7,44,240 cum/day. Considering average effective depth of 5m, the area requirement of raw water reservoir comes out to be 37 acres. However, the area allotted to raw water reservoir as shown in plot plan is approx. 17 acres. Hence, Bidder requests Owner to clarify on the area requirement or storage capacity.	Tentative area for Raw Water Reservoir is already shown in Plot Plan attached with the Tender document. Bidder should design the structure/system accordingly. Further discussion, if required, on this issue shall be taken up during detail engineering.

EPC PACKAGE OF 1X660 MW PANKI THERMAL POWER EXTENSION PROJECT

ADDITIONAL CLARIFICATIONS TO QUERIES RAISED BY M/s BHEL VIDE E-MAIL DATED 16.07.2015

SL. NO.	BID DOCUMENT REFERENCE	BIDDER'S QUERRY	UPRVUNL'S REPLY
1	VOL VI; CHAPTER:05; Pg. 1 OF 4	Report of Preliminary soil investigation work available with UPRVUNL within proposed Power Plant area covering major structures/facilities tentatively located shall be provided to the bidders.	Shall be provided shortly.
2	VOL VI; CHAPTER:03; Pg. 3 OF 5	Map indicating all crossings like high ways / railways / nala / river and bridges etc. may be collected from owner's office.	Soft copy of full map of Panki TPS is attached. The information provided in the map is tentative. For detail information bidder has to visit the Panki site.
3	General	AUTOCAD drawing of Plot Plan, Site Plan, E-SLD & Contour Map.	AUTOCAD drawing shall be provided to selected bidder during detail engineering.
4	Vol.-II Mandatory spares	Editable copy of Datasheets, mandatory spares and schedules.	Soft copy of Editable copy of Datasheets, mandatory spares and schedules is attached herewith.
5	General	Topographical survey Drawing/ Report	Already provided with L&T queries.
6	General	Area Drainage Study Report	Area drainage for proposed plant is in EPC bidder's scope. Study of drainage for overall area shall be carried out by EPC contractor only. However, full map of Panki TPS indicating drains attached.
7	General	The drawing of existing transmission lines routed from proposed cooling tower area as well as ash slurry.	Soft copy of hand sketch of existing transmission lines routed from proposed cooling tower area is attached. For detail information bidder has to visit the Panki site.
8	General	AWRS piping layout (which is going to existing ash pond).	Soft copy of hand sketch of AWRS piping layout (which is going to existing ash pond) marked on plot plan is attached. For detail information bidder has to visit the Panki site.
9	Vol.-III Ch. 4 page 1 of 13 cl. 4.1.1	Please clarify the 'minimum & maximum water level' of the Lower Ganga canal to be considered for intake system design purpose.	Details of Lower Ganga Canal:- Ground Level =124.338m Bed Level =122.727m Bed Width = 17.10m Water Depth =2.10 m HFL = 124.827 m

1x660 MW PANKI THERMAL POWER STATION EXTN.

CLARIFICATIONS ON AMENDMENT-5 (Part-1)

Sl. No.	Volume/ Chapter	Tender Specification	Clarifications/Deviations	Remarks by customer
1.	Amendment 5 (Site Plan)	Plot plan: 14A14-DWG-M-029,R4	Kindly note that Legend for the rail track as shown in the Site plan drawing are as follows: - proposed - existing - to be dismantled Bidder is not able to clearly identify the legends shown in the plot plan PDF Format given as per Amendment-5. Hence, request customer to furnish AUTO CAD copy of the plot plan.	Railway is not in scope of EPC contractor. However coloured PDF copy of drawing is enclosed.
2.	Amendment 5 (Site Plan)	Plot plan: 14A14-DWG-M-029,R4 1. “Proposed ash silo” is shown in the plot plan on BC 5A/B,(Near JT 4)	Kindly note that “Proposed ash silo” location as shown in the plot plan is interfering with BC5A/B. We request customer to clarify that ash silo on BC-5A/B, (Near to JT 4) as shown in the latest plot plan is proposed or existing as this silo has nothing to do with this tender requirement. If it is existing silo & it is interfering with BC 5A/B. in view of this, whether bidder has to dismantle the silo or not. If it is proposed ash silo for this project, kindly specify the purpose of the same and furnish its capacity.	“Proposed ash silo” as shown is not in scope of EPC contractor nor it is existing.
3.	Amendment 5 (Site Plan)	Plot plan: 14A14-DWG-M-029,R4 1. Wagon sick line and Empty Track line No.1 CSR 750M are going inside JNT 4 2. Gallery of BC 4A/B is shown above wagon sick line.	We once again request customer to review layout as railway tracks are going inside the JT 4 and interfering with trestles of BC 4A/B and its foundation. If bidder has to follow same layout, we request customer to obtain necessary approvals form railways during detailed engineering.	EPC contractor to take care in detail engineering.
4.	Amendment 5 (Site Plan)	Plot plan: 14A14-DWG-M-029,R4 1. LOCO Shed (24M X 30 M)	Loco shed of 24MX30M is shown in the latest plot plan.(This Was not shown in earlier plot plan) In view of this, we request customer to confirm whether it is to be included in the bidder's scope or not.	Loco shed is not in EPC contractor's scope.

1x660 MW PANKI THERMAL POWER STATION EXTN.

CLARIFICATIONS ON AMENDMENT (PEM) (Part-2)				
S. No.	Vol/Sec/Cls./Sheet Nos.	Amendment-5 Requirement	Clarification	Remarks by Customer
1.	Amendment 5 (Mechanical System) Sl. no. 12, page 5 of 70.	On installation of FGD the Temp of Flue Gas at chimney inlet shall be 80 degC or lower.....temp of flue gas	Due to Lower temperature specified for FGD, customer may inform the flue exit velocity (and the corresponding load) to be considered for chimney sizing.	The optimum range of velocity may be taken as 15 to 20 m/sec. However, velocity will not exceed, under any circumstances, 30 m/sec
2.	Amendment 5 (Mechanical System) Sl. no. 15, page 7 of 70.	Temperature rise in circulation water across the condenser – Not exceeding 10 deg C against VWO , 1% makeup and 33 deg C inlet water temperature.	Customer to note that there is a contradiction in the amendments regarding DM Make up water requirement to be considered for Cycle Make up. Customer is requested to review and clarify.	1.5% shall be considered for DM water plant sizing and DM water make up system. 1% is specified for identifying the guarantee condition of turbine cycle.
	Amendment 5 (Mechanical System) Sl. no. 19, page 7 of 70.	DM water normal make up to thermal cycle is 1.5% of the throttle steam flow.		
3.	Amendment -5. DWG no- 14A14-DWG-M-014 (Sht 1 of 2). Point no- 10 of NOTES.	10. Bidder will design Plant considering the above water scheme as of minimum requirement. However, Bidder to ensure & demonstrate that plant operate at optimized condition as per latest MOEFF norms.	The minimum requirement of Raw water shown in Composite Water scheme (2484 M3/hr without Recovery, i.e 3.76 M3/Hr/MW and 2080 M3/hr with recovery i.e 3.17 m3/Hr/MW) does not meet the latest MOEF norms of 2.5 M3/Hr/MW along with ZLD (Zero Liquid Discharge). Please review the same. Customer to mention optimized condition of plant operation to demonstrate as per MOEFF norms.	For design purpose, Bidder will follow composite water scheme (14A14-DWG-M-014) as of minimum requirements. However, For MOEF compliance plant shall be considered to run with bottom ash in lean slurry with water recovery and fly ash in HCSD as being presented to MOEF.

BHARAT HEAVY ELECTRICALS LIMITED

EPC Package for 1x660 MW Panki TPS Extension Project

PRE-BID CLARIFICATIONS/ DEVIATIONS

S. No.	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	BHEL's COMMENTS / CLARIFICATIONS	UPRVUNL's REPLY
	Vol /Ch	Chapter Name	Sheet No.	Clause No.			
CIVIL							
1	III/25	Air Conditioning & Ventilation System	Page 4 of 40	25.3.19	Air conditioning system for Service Building, Administration Building & Training Centre Building shall be designed with ECBC code to make it “Green Building”.	Customer is requested to note that no green building requirement has been envisaged in the specifications. Only AC system for Service Building, Administration Building & Training Centre Building has been asked to be designed with ECBC code. As such bidder understands that only AC system for these buildings shall be supplied as per ECBC code. Please confirm if bidder understanding is correct.	Bidder to follow specification.
2	File name 1D_PEM_Part IV:					Customer to note that there are contradiction in the various replies of pre bid queries raised by bidder. As per contour map provided by owner, Plant area is at RL (+) 97.5m (approx.). However	All levels mentioned in contour drawing may be adjusted for +27.5 m. in respect to MSL. However, the FGL will be decided during
	1.	II/Chapter 2	General Project Information	1 of?	1.13	Plant FGL at EL (-) 0.5m and RL (+) 126m As per tender drawing No. 111-29-0100 (PLOT PLAN) Contours in BTG Plant area are not shown. However in nearby areas contour is at HL (+) 96.0m. Therefore, there is a large difference between contour level and FGL, of this area. Customer is requested to provide BTG contour levels and confirm FGL. Bidder's observation is correct. However, the FGL will be decided during detail engineering based on existing contour and other technical requirement. Contour map has already been provided with the clarifications of L&T	

BHARAT HEAVY ELECTRICALS LIMITED

EPC Package for 1x660 MW Panki TPS Extension Project

PRE-BID CLARIFICATIONS/ DEVIATIONS

S. No.	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	BHEL's COMMENTS / CLARIFICATIONS	UPRVUNL's REPLY
	Vol /Ch	Chapter Name	Sheet No.	Clause No.			
	File name 1D_PEM:						
19.	VI/ 02	Scope of Work	4 of 8	2(55)	Minor Site grading and levelling upto 500 mm is in the scope of bidder. Finish ground level of entire plant area will be RL.....m above mean sea level. FFL of all other buildings, roads and drains will be	FGL and HFL to be confirmed by customer. The same is not mentioned in the Plot Plan. Please confirm.	Plant FGL RL. (+) 126.0 M Ref. Vol.-II Book 1 of 2 Ch. 02; Cl No. 1.0; Page No. 1 of 7.
Contour Map Provided Along with Pre bid replies						Bidder understands that FGL is at RL (+) 97.5m (as per contour map provided by owner) and only Minor site grading and leveling up to 500mm is in the scope of bidder (Cl. No. 55; Sheet no. 4 of 8; Vol VI (civil)). Please confirm if bidder understanding is correct.	detail engineering based on existing contour and other technical re-quirement.

UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)

TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	OWNER'S REPLY	RESOLUTION IN MEETING BETWEEN UPRVUNL, DCPL & BHEL ON 05.01.2016 AT DCPL, KOLKATA OFFICE
	Vol / Sec	Sub Sec	Page No.	Clause No.				
CIVIL								
72.	VOL-III/CHAPTER 13	Rain Water Harvesting	1 of 3	13.1	Minimum capacity of rain water harvesting pond shall be 50,000 cum and that shall be in the construction yard area surrounded by landscaped garden.	Earthen reservoir without lining has been considered for rain water harvesting. Kindly accept.	Bidder to follow specification and submit rainwater harvesting scheme.	Owner's Reply Prevails. ISSUE CLOSED.
73.	VOL-VI/CHAPTER 02	Scope of Civil & Structural Works	5 of 8	2.6 (63)	Training center.	Since the Training centres is non plant building and the layout of Training centre depends on customer requirement, customer is requested to inform the size of building to be considered by all bidders for estimation. In absence of data regarding covered area & floor details etc. in specification. Bidder considered following for Training centre. a) Total area = 250 Sqm-Single storey RCC building. b) One AC Conference room for of size =90 Sqm. c) One reception of = 20 Sqm (AC area) d) One Hall for library = 50 Sqm. (AC area) e) Office Room & faculty room = 30Sqm (AC area) f) Toilets for Ladies & Gents = 20Sqm g) Pantry = 8 sqm h) Utility area = 12 Sqm i) A Porch of size 5m x 4m will be provided. The finishing of walls, floor, and other specification shall be similar to Service building. No Furniture, furnishing, office equipment, partition/paneling for office, etc. is considered in the scope of bidder. Customer is requested to issue suitable amendment or confirm the size considered.	Additionally bidder should consider at least 2 numbers class rooms of 30 students each including the following details.	Owner's Reply Prevails. ISSUE CLOSED.
74.	VOL-VI/CHAPTER 06	General Requirement of Building & Structure	8 of 11	6.13 (SECURITY GATE)	The road near the main entrance to be widened additionally by 7.5 m on either sides of the road for parking of vehicles for security check.	30m length of road is considered by bidder for parking of vehicles for security check. Please confirm.	It is presumed that Bidder had already visited site and collected required data. Length of road shall be decided during detail engineering as per approved Plot Plan. Bidder must confirm that any change in length of road during detail engineering shall be accommodated by him without any implication to Owner (UPRVUNL).	Bidder agreed. ISSUE CLOSED.

5/1/16
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UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)
TECHNICAL CLARIFICATIONS & DEVIATIONS

SL. NO	ENQUIRY SPECIFICATION				SPECIFICATION REQUIREMENT	DEVIATION	OWNER'S REPLY	RESOLUTION IN MEETING BETWEEN UPRVUNL, DCPL & BHEL ON 05.01.2016 AT DCPL, KOLKATA OFFICE
	Vol / Sec	Sub Sec	Page No.	Clause No.				
75.	VOL-VI/ CHAPTER 06	General requirement of Building & Structures	8 of 11	6.12 (PAVING)	Suitable drains shall be provided... The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain.	Disposal point of Plant Storm water drain has been considered near the existing disposal point (near state highway junction opposite to proposed chimney of 1x660MW TPP)	Final location of disposal/outfall of plant storm water drainage shall be decided during detail engineering. Bidder should note that nothing extra shall be payable due to change in location of disposal/outfall during detail engineering.	Specification prevails. Bidder has withdrawn the deviation. ISSUE CLOSED.
76.	VOL-VI/ CHAPTER 02	Scope of Civil & Structural Works	2 of 8	2.6(57)	Plant boundary. Existing plant boundary has to be demolished in designated areas and new security wall with concertina fencing at top to be constructed as per layout of proposed 1x660 MW plant and site Requirement.	After site Visit bidder understands the following: - Boundary Wall along the existing Ganga canal and along the state Highway shall not be dismantled nor strengthened. - Boundary wall along the switchyard (west side of plant) shall be constructed in the proposed plant area only. - Boundary wall along the road opposite to ash dyke which comes in the proposed plant area shall be strengthened. - Raw water Reservoir shall not be covered within proposed plant boundary wall. Please confirm if bidder's understanding is correct.	Bidder's assumption not acceptable Tender specification shall prevail.	Amendment shall be issued.
77.	VOL-III/ CHAPTER -25	Air Conditioning & Ventilation System	4 of 40	25.3.19	Air conditioning system for Service Building, Administration Building & Training Centre Building shall be designed with ECBC code to make it "Green Building".	Customer is requested to clarify the following: A. As per tender specification Only Air conditioning system for Service Building, Administration Building & Training Centre Building shall be designed with ECBC code or B. Service Building, Administration Building & Training Centre Building shall be designed with ECBC code to make it green building. If so customer is requested to inform the GRIHA rating or only Customer is requested to issue suitable amendment in case B is to be followed	Bidder to follow specification.	Owner's Reply Prevails. ISSUE CLOSED.
78.	VOL-VI/ CHAPTER 02	Scope of Civil & Structural Works	6 of 8	72.0	Dispensary and first aid center.	Since the dispensary and first aid centres are non-plant buildings, customer is requested to inform the size of building to be considered by all bidders for estimation. In absence of size we have considered the size of Dispensary Bldg. has been considered as below 14m (length) x 12m (width) x 4m (Height). Customer is requested to issue suitable amendment or confirm the size considered..	Noted	ISSUE CLOSED.

5/1/16

5/1/16

5/1/16

UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)
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	Vol / Sec	Sub Sec	Page No.	Clause No.				
79.	VOL-VI/CHAP-TER -07	Material	1 of 1	7.1	Complete hopper including vertical and conical portion of the bunker in mill building shall be provided with lining of at least 6mm thick SS plate grade SS 316L	SS 304 provides better finish profile inside bunker. Bending and stitching of plate inside bunker with higher thickness of plate (6mm) is very difficult, and technically not required. To reduce the friction inside conical hopper with SS 304 plate of thickness 3.15mm is having excellent advantage. Bidder advice to use SS plate in hopper portion only, and it is also the current practice in case of circular bunker design. Customer is requested to review the requirement and confirm acceptance.	Bidder should strictly follow Specification.	Owner's Reply Prevails. ISSUE CLOSED.
80.	VOL-VI/CHAP-TER - 11	description of buildings, structures and other facilities	7 of 19	11.3	The grade of the SS liner shall be SS316L	The SS-316L generally provides glossy finish and used mainly in architectural work to improve esthetic look. SS304 is best to achieve minimum friction on the conical hopper with better finish therefore, bidder suggest to adopt SS-304 plate in place of SS-316L plate. Customer is requested to review the requirement and confirm acceptance.	Bidder to follow specification.	Owner's Reply Prevails. ISSUE CLOSED.
81.	VOL-VI/CHAP-TER - 07	Material	1 of 1	7.2	Ordinary Portland Cement (OPC) Grade 43 shall be used for all structures.	OPC shall be used for TG, BFP, FANS, MILLS, MILL BAY and BOILER FDN and for other areas pozzolana cement (PPC) may also be allowed. Please confirm.	Bidder to follow Specification.	Owner's Reply Prevails. ISSUE CLOSED.
82.	VOL-VI/CHAP-TER - 17	Architectural Works	17 of 21	17.7.9	All the exposed structural steel i.e. wall, columns, bracings in STG control room and air-conditioning areas shall be provided with wooden wall paneling.	As wood is prone to fire hazards, bidder understands that portion of the structural steel column projecting into the room in STG control room and air conditioned area shall be encased with brick masonry and painting as per specification to shield it from fire hazards and improve esthetic look. Please accept.	Bidder to follow specification. Necessary precaution for fire prevention shall be taken care by bidder.	AMENDMENT-1 already issued.

5/1/16

5/1/16

5/1/16

UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)
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	Vol / Sec	Sub Sec	Page No.	Clause No.				
83.	VOL-VI/ CHAPTER - 11	Building Description	7 of 19	11.3	Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor up to 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent color coated Galvanized trough sheet cladding shall be provided.	Above the brick wall permanent color coated Galvanized trough single sheet cladding shall be provided with thickness of sheet similar to power house as per current practice of bidder. Kindly accept.	Bidder must comply Specification requirements.	Owner's Reply Prevails. ISSUE CLOSED.
84.	VOL-VI/ CHAPTER - 11	Building Structure	7 of 19	11.3	Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min. 50 thick screed over the water proofing treatment.	Slope on the RCC roof shall be provided either by slope in the structural member of roof or by screed concrete over the RCC slab with a minimum thickness of screed 25mm on the edge of roof and a slope of 1:200. Kindly accept.	Bidder to follow Specification.	Structural slope of roof of Mill Building not acceptable. Owner's Reply Prevails. ISSUE CLOSED.
85.	VOL-VI/ CHAPTER - 12	Reinforced Concrete Chimney	5 of 22	12.3.10 (10)	"Embedment to support the stair case shall be provided in the shell", it is implied that staircase is supported on shell.	Platform girder are supported as sliding support, while staircase support is firmly fixed at ground and is a continuous structure from level 0.0m to top of chimney. Interconnection of platform with structure of staircase will prevent platform from sliding which may be detrimental for chimney platform and liner. So it is proposed that staircase should be firmly supported on the chimney shell with MS- inserts.	Please refer AMENDMENT-1, CIVIL PART, Sl. No. 21.	ISSUE CLOSED.
			13 of 22	12.13	"The staircase shall be supported by a structural steel framework supported from platform to platform independently of the wind shield."		Bidder should follow Specification.	Owner's Reply Prevails. ISSUE CLOSED.
86.	VOL-VI/ CHAPTER - 12	Reinforced Concrete Chimney	16 of 22	12.23	"The laser scanning of chimney shell after every 70 m height and on completion should be performed".	Kindly clarify that Laser screening is for verticality check during construction only.	Specification clause is self-explanatory. Bidder to follow specification.	Owner's Reply Prevails. ISSUE CLOSED.

15/1/16

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5/1/16

UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)
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	Vol / Sec	Sub Sec	Page No.	Clause No.				
87.	VOL-VI/CHAPTER - 12	Reinforced Concrete Chimney	3 of 22	12.3.10	The heat insulation of the liners and pressurized ventilation system shall be so designed that temperature in annular space between the chimney shell and flues does not exceed 45 Deg.C in peak summers.	Pressurized ventilation system is neither possible nor required in single flue steel liner with gratings platforms. Therefore, natural ventilation shall be provided. Kindly Accept.	Bidder must confirm that temperature in annular space between the chimney shell and flues does not exceed 45 Deg.C in peak summers.	Owner's Reply Prevails. ISSUE CLOSED.
88.	VOL-VI/CHAPTER - 2	Scope of work	2 of 8	2.6 (14)	Modification (if required) of existing return channel...	Length, location & layout of return channel is not clear as per Plot Plan. Therefore, no length has been considered for dismantling/construction. Kindly Accept.	Modification (if required) of existing return channel shall be under scope of this package. Bidder should assess the quantum of work and follow specification.	Bidder agreed. Owner's Reply Prevails. ISSUE CLOSED.
89.	VOL-VI/CHAPTER - 13	Civil Design Basis	6 of 25	13.7.1.2	For coefficient 'K2', Terrain category '1' and class 'C' as per table 2 of IS: 875 (Part-3) – 1987 (Latest) shall be considered.	As per site condition/location & IS: 875 (Part-3), Terrain category '2' shall be considered for proposed plant including cooling tower & chimney. Please accept.	Bidder should follow Specification.	Owner's Reply Prevails. ISSUE CLOSED.
90.	VOL-VI/CHAPTER - 21	Water closet	11 of 12	21.9 g.)	One toilet with required facilities shall be provided for physically challenged persons as per National Code requirements in GRIHA rated buildings.	As per Specification there is no GRIHA rated building, however one toilet for physically challenged persons shall be provided as per this clause.	Noted. Also note that Administrative Building shall be designed as GREEN Building.	Owner's Reply Prevails. ISSUE CLOSED.
91.	DWG NO.14A 14-DWG-M-001	PLOT PLAN			Plot Plan (Item No.-43)	In the Plot plan township has been marked. As per specification bidder understand that township construction is not in bidder's scope. Please confirm.	Noted	ISSUE CLOSED.

5/1/16

5/1/16

5/1/16

UPRVUNL, PANKI THERMAL POWER STATION (1 X 660 MW)
TECHNICAL CLARIFICATIONS & DEVIATIONS

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	Vol / Sec	Sub Sec	Page No.	Clause No.				
92.	VOL-VI/CHAPTER - 10	RCC Structure & Foundation	13 of 43	10.14	The total permissible settlement and differential settlement of the foundations will be governed by IS: 1904, IS: 13063 and from functional requirements whichever is more stringent. Maximum allowable total settlement should be restricted to 25 mm for foundations of all plant structures like cooling towers, CW pump house, DM plant, crusher house, transfer house, Power House, TG foundation, Mill foundations, Fan foundations, Crusher foundation etc., Maximum allowable total settlement should be restricted to 40 mm for all other foundations...	Total permissible settlement and differential settlement of foundations shall be per IS: 1904, IS: 13063 and from functional requirements whichever is more stringent. Accordingly total permissible settlement for CW pump house, DM plant, crusher house, transfer house, ESP foundation/ESP control room and other structures related to BOP shall be 40mm and 75mm (raft foundation) and for Power House, TG foundation, Mill foundations, Fan foundations etc, total permissible settlement shall be 25mm.	Bidder should comply Specification requirement.	Owner's Reply Prevails. ISSUE CLOSED.
93.	VOL-VI/CHAPTER - 10	RCC Structure & Foundation	29 of 43	10.21	Reinforcement: The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 500 conforming to IS: 1786 – latest.	The reinforcement used shall be high strength deformed TMT bar of grade Fe 500 conforming to IS: 1786 – latest.	As per specification.	Amendment shall be issued.
94.	VOL-VI/CHAPTER - 18	Piling	5 of 10	18.8	Load Tests on Piles...	Load test and evaluation of the safe load on pile for vertical compression, Pull out & lateral shall be as per IS 2911- part-IV: 2013.	As per Specification.	Owner's Reply Prevails. ISSUE CLOSED.
95.	VOL-VI/CHAPTER - 12	Reinforced Concrete Chimney	13 of 22	12.15	Lift shall be provided for the chimney inside the wind shield.	Lift shall be provided for the chimney outside the wind shield. Kindly Accept.	Not acceptable. Bidder should follow specification.	Owner's Reply Prevails. ISSUE CLOSED.

5/1/16

5/1/16

5/1/16

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	Vol / Sec	Sub Sec	Page No.	Clause No.				
96.	VOL-VI / CHAP-TER - 10	RCC Structure & Foundation	14 of 43	10.14	In case of open foundations without piles, Ground improvement methods opted by contractor, like sand drains / stone columns etc. to reduce settlement and increase the rate of settlement, detail methodology of such installation supported by calculation based on relevant field data shall be furnished for approval of Owner / Consultants before execution. In the event, the contractor adopts any patented method of ground improvement or retain any specialized agency for such purpose, the same can be done subject to prior approval of owner.	As per tender specifications Ground improvement, is not considered when pile foundation is adopted. Type of foundations (open/pile) for various buildings and structures shall be adopted as per approved geo technical investigation report during execution stage. In building and structures open foundation shall be adopted with/without ground improvement as per approved geo technical investigation report during execution stage for various areas. Please accept.	During bidding stage Bidder must assess the type of foundation to be adopted for different structures/buildings/systems. However, actual type of foundation (pile/footing/raft etc.) shall be decided during detail engineering on the basis of geotechnical investigation to be carried out by successful Bidder and approved by UPRVUNL. Bidder must note that nothing extra whatsoever on account of variation between type of foundation assumed by Bidder at this stage and that found by detailed geotechnical investigation to be carried out by Bidder shall be payable.	Owner's Reply Prevails. ISSUE CLOSED.

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**UTTAR PRADESH RAJYA VIDYUT
UTPADAN NIGAM LIMITED
[UPRVUNL]**



1 x 660MW PANKI TPS EXTN.

VOLUME II-B

**CIVIL, STRUCTURAL AND ARCHITECTURAL
WORKS**

SECTION – D

GENERAL TECHNICAL SPECIFICATION



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

SECTION – D comprises of sub-sections as mentioned below:

Sub-section D1: Earthwork in excavation and backfilling

Sub-section D2: Cement concrete (Plain and reinforced) and formwork

Sub-section D3: Carpentry and joinery

Sub-section D4: Roof and underground structures water proofing, insulation and allied works

Sub-section D5: Metal doors, windows, ventilators, louvers etc.

Sub-section D6: Glass and Glazing

Sub-section D7: Rolling Steel Shutter and Grills

Sub-section D8: Miscellaneous Metal

Sub-section D9: Masonry and allied works

Sub-section D10: Finish to masonry and concrete

Sub-section D11: Painting, Whitewashing, polishing

Sub-section D12: Floor finish and allied works

Sub-section D13: Sheet work in roof and siding

Sub-section D14: Suspended ceiling

Sub-section D15: Water supply, drainage & sanitation

Sub-section D16: Road & drainage

Sub-section D17: Fabrication of structural steelwork

Sub-section D18: Erection of structural steelwork

Sub-section D19: Roof decking

Sub-section D20: False flooring

Sub-section D21: Bored cast-in-situ RCC piles

Sub-section D22: Site levelling & grading works

Sub-section D23: Anti-termite treatment



TITLE:
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D1	
REV.NO.	00	DATE	09/04/2018
SHEET	1	OF	21

VOLUME: II B

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
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SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 2 OF 21

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.0	SCOPE	3
2.00.00	GENERAL	3
3.00.00	EXECUTION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	19
5.00.00	RATES AND MEASUREMENTS	19
6.00.00	INFORMATION TO BE SUBMITTED BY THE BIDDER	20



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 3 OF 21

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

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under 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) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

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. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

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



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 EARTHWORK IN EXCAVATION AND
 BACKFILLING**

SPECIFICATION NO. PE-TS-999-600-C001
 VOLUME - II B
 SECTION - D | SUB-SECTION - D1
 REV.NO. 00 DATE 09/04/2018
 SHEET 4 OF 21

2.3.0 Codes and Standards

All works 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	Method of measurement of building and civil engineering works, Part-I: 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	Indian Standard 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 this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

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

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 5 OF 21

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 backfilling 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. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm 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	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

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.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 6 OF 21

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 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 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 same shall be rectified by the contractor at his own risk and cost.

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

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise 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 to the approved disposal



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EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 00 DATE 09/04/2018

SHEET 7 OF 21

area(s) as specified by the engineer. Useful materials, saleable timber, fire woods 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

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



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 8 OF 21

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) Hard Rock (requiring blasting)

This shall include :

- i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
- ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
- iii) boulders requiring blasting.

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 excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and 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 the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 9 OF 21

The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out 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 (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2

Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. 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. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 10 OF 21

engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of 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. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

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 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.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 11 OF 21

3.5.4.1 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.

3.5.4.2 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. 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



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 12 OF 21

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.

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 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.

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 his



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 13 OF 21

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 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.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 14 OF 21

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.

3.5.4.5 Restrictions in 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.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

- a) By using it straightway for backfilling.
- b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.
- c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.
- a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 15 OF 21

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 16 OF 21

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. 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 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden 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 excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from 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 case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 17 OF 21

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree 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 surface of fill shall be trimmed to the slope intended to be provided for the floor.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 18 OF 21

3.7.4 Filling in Trenches for Water Pipes and Drains

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 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be 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 the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation 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 around 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.



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

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 00 DATE 09/04/2018

SHEET 19 OF 21

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension 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 are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 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 section 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.

d) 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.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 00 DATE 09/04/2018
SHEET 20 OF 21

5.2.0

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

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 respectively 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 excavation 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 rock so arrived shall be taken as soil.

6.0.0

INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0

With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.



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

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION – D1
REV.NO. 00 DATE 09/04/2018
SHEET 21 OF 21

6.2.0

After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 56

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

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

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**



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 56

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	INSTALLATION	12
4.00.00	SAMPLING AND TESTING	41
5.00.00	ACCEPTANCE CRITERIA	43
6.00.00	RATES AND MEASUREMENTS	43
7.00.00	LIST OF I.S.: CODES AND STANDARDS FOR REFERENCE	51



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 56

SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate 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. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

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

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 56

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- 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.

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 Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

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

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's 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 with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02

After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

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 free of cost, for approval. The Engineer for future reference will preserve approved samples. 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.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 56

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with 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) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00

Conformity with Design

The Contractor will prepare checklists in approved Form, 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 7 OF 56

Cards 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. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 8 OF 56

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are 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 in works. Sand shall be hard, durable, clean and free from adherent coatings or 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.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures 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 IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture
- e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 9 OF 56

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTM C-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

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

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses 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.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 10 OF 56

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.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

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 affects 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.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 11 OF 56

Material tests or Certificates to satisfy relevant IS Specification.

- 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.
- 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 & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00

INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 12 OF 56

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval 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 owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

“Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made 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 M-15 or lower only 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 13 OF 56

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02

Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. 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.

3.05.00

Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00

Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 14 OF 56

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

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

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 15 OF 56

3.07.02

Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should 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. Trial mix shall be carried out accordingly. 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.

3.08.00

Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 16 OF 56

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space - 12 mm

Reinforced concrete
Except foundation - 20 mm



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 17 OF 56

Ordinary Plain concrete and Reinforced
concrete foundations - 40 mm

Mass concrete - 80 mm

Lean concrete - 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

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.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 18 OF 56

shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00

Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying 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, in spite of all precautions, segregations 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.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 19 OF 56

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

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 or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 20 OF 56

placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & 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.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, 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 there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

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 at the middle of the span.
- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 22 OF 56

placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise 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.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & 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.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 23 OF 56

- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. 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 reinforced 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 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) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, 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. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound 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 a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 25 OF 56

acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

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 the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. 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. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 26 OF 56

other harmful matters immediately before placing the concrete.

3.16.03

Bending

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 with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, 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 shall be bent by machine or other approved means producing a gradual and even motion. 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.

3.16.04

Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. 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 or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05

Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted 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. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 27 OF 56

Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. 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 does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 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 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 28 OF 56

contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring 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 centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure 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 and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified 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 in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. 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 vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust 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 or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or reproping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 30 OF 56

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer 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 there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- | | |
|--------------------------|--|
| a) Sectional dimension - | ± 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 & should not be taken as tolerances for the entire structure



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 31 OF 56

taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- 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 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 by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 32 OF 56

to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame 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) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 33 OF 56

laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by

the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 35 OF 56

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, 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 & the edges accurately.

c) 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 or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°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 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 SOA
Tensile Strength	:	10 - 15 N/Sq.mm



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 36 OF 56

Maximum Safe Continuous
Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or 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.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips 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 specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 37 OF 56

3.25.00

Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) 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. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after 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 per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00

Waterproofing of Concrete Structure

3.26.01

General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the

Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02

Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall 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	-	5 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.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 39 OF 56

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be 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 reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

- a) Nozzles spaced as required after the concrete is completed shall be drilled



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 40 OF 56

into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 41 OF 56

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 42 OF 56

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. 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 Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder 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 that, at regular intervals



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 43 OF 56

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.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests 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 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 at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

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

5.02.00 Acceptance Criteria

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

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 44 OF 56

strength.

If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.
- b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include all arrangement for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 45 OF 56

payable to the contractor as per BOQ item.

- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.
- b) No deductions shall be made for the following:
 - i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;
 - ii) Opening upto 0.1 sq.m.
 - iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23°C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 46 OF 56

- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.
- c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.
- d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 47 OF 56

- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02

Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00

Embedded Parts

6.04.01

Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 48 OF 56

shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.
- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 49 OF 56

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.
- f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

- a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

- b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

- c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 50 OF 56

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 51 OF 56

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 -	Indian Standard Specification for Paving Bitumen
IS: 216 -	Indian Standard Specification for Coal Tar Pitch
IS: 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
IS: 455 -	Indian Standard Specification for 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 52 OF 56

Structures

- IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete
- IS: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
- IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
- IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement
- 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 Steel Bars and Wires for Concrete Reinforcement.
- IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.
- IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
- IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks
- 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: 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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 53 OF 56

- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS: 2571 - Code of practice for laying in-situ cement concrete floors.
- 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: 2750 - Indian Standard Specification for steel scaffoldings.
- IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
- IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
- IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
- IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses
- IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- 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 Scaffolding and Ladders
- IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
- IS: 4014 - Code of practice for steel tubular scaffolding.
- IS: 4031 - Indian Standard Specification for Method of Tests for



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 54 OF 56

Hydraulic Cement

- IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
- IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches
- IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes
- 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
- 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 of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
- IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.
- IS: 5256 - Code of practice for sealing joints in concrete lining on canals.
- IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolan materials
- IS: 5513 - Indian Standard Specification for vacate Apparatus.
- IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.
- IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS: 5624 - Indian Standard Specification for foundation bolts.
- IS: 5751 - Indian Standard Specification for Precast Concrete Coping



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 55 OF 56

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: 5892 - Indian Standard Specification for transit mixer and agitators.
- IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS: 6909 - Indian Standard Specification for Super sulphated 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: 7293 - Safety code for working with construction machinery.
- IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.
- IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.
- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 56 OF 56

- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shortcreting.
- 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 Reinforcement in RB and RCC Construction.
- IS: 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS: 10262 - Recommended Guidelines for Concrete Mix Design.
- IS: 13311 - Non-destructive testing of concrete.
- SP: 34 - Handbook of concrete, reinforcement and detailing.



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 7

VOLUME: II B

SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003



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



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 7

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	6
5.00.00	RATES AND MEASUREMENTS	6



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 7

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number of joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). 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. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 7

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 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, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to 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.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 7

2.02.02 Finish

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.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of 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 bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 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.

3.02.00 Door and Window Shutters

All doors 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.

3.03.00 Partitions, Paneling, Pelmet, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 7

3.03.03 Pelnets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

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 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: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)

IS: 1003 - Timber panelled and glazed shutters.

IS: 2191 - Wooden flush door shutter (Cellular and hollow core type).

IS: 2202 - Wooden flush door shutters (solid core type).

IS: 4021 - Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 7 OF 7

holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00

Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 14

VOLUME: II B

SECTION – D

SUB-SECTION – D4

**ROOF AND UNDERGROUND STRUCTURES WATER
PROOFING, INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004



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



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 14

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE	12
4.00.00	I.S. CODES AND STANDARDS	12
5.00.00	RATES AND MEASUREMENTS	13



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 14

**ROOF AND UNDERGROUND WATER PROOFING,
INSULATION AND ALLIED WORKS**

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 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 25mm 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.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand 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.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 14

by volume with 12 mm 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.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications 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 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight 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 precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. 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 withstand the usual workload 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.

2.02.02 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/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 14

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 secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

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 volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02

Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists 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 over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 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 a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised 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 in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 10 OF 14

2.04.03 Waterproofing 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 fire, sun exposure, and light duty 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 labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer 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 or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- a) 2 layers - for depths up to 5m below ground level
- b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384
- ii) Hot applied bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base bitumen felt type 3 grades 2
- iv) Hot applied bitumen at the rate 1.2 Kg/m²
- v) Hessian base bitumen felt type 3 grades 2
- vi) Hot applied bitumen at the rate of 1.2 Kg/m²



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 12 OF 14

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00

ACCEPTANCE CRITERIA AND GUARANTEE

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 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 works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 13 OF 14

4.00.00

I.S. 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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- 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: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00

RATES AND MEASUREMENT

5.01.00

Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the “Schedule of Items”.

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00

Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE : 30/11/2015

SHEET 14 OF 14

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005		
VOLUME - II B		
SECTION - D	SUB-SECTION - D5	
REV.NO. 00	DATE 09/04/2018	
SHEET 1	OF	15

VOLUME: II B

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-999-600-C005



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



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005
VOLUME - II B
SECTION - D | SUB-SECTION – D5
REV.NO. 00 DATE 09/04/2018
SHEET 2 OF 15

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	INFORMATION TO BE SUBMITTED	9
5.00.00	I.S. CODES	10
6.00.00	RATES AND MEASUREMENTS	10

ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 3 OF 15

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.**1.00.00 SCOPE**

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION**2.01.00 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.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified 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. 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. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. 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. 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 end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 4 OF 15

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered 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 installed. 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 the 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, or called for in the schedule of items, 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 drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION – D5

REV.NO. 00 DATE 09/04/2018

SHEET 5 OF 15

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 fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) “Double Plate Flush Door Shutters.”

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction 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 called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. 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.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 6 OF 15

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the 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 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

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. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 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. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. 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 be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, 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



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 7 OF 15

himself that the items supplied are up to 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.

2.05.00

Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to 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 all 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, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good 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 cement in original sealed containers of manufacturer and shall apply it as per the instruction. 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 from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0

Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the

	TITLE: TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.	SPECIFICATION NO. PE-TS-999-600-C005 VOLUME - II B SECTION - D SUB-SECTION – D5 REV.NO. 00 DATE 09/04/2018 SHEET 8 OF 15
	requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating. Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side. All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting. 3.00.00 ACCEPTANCE CRITERIA 3.01.00 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 mitered corners. j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers. k) Shop coats shall be properly applied. l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.	SPECIFICATION NO. PE-TS-999-600-C005 VOLUME - II B SECTION - D SUB-SECTION – D5 REV.NO. 00 DATE 09/04/2018 SHEET 9 OF 15
3.02.00	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. 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 be engage positively. Key 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 discoloration.	
4.00.00	INFORMATION TO BE SUBMITTED	
4.01.00	With Tender	
	a) Names of manufacturers for Doors, windows etc. b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.	
4.02.00	After Award	
	a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings. b) He shall submit a programme of work to be done for the approval of the Engineer. c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.	

	TITLE: TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.	SPECIFICATION NO. PE-TS-999-600-C005																														
		VOLUME - II B																														
		SECTION - D SUB-SECTION – D5																														
		REV.NO. 00 DATE 09/04/2018																														
		SHEET 10 OF 15																														
5.00.00	IS CODES 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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table border="0"> <tr> <td>Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)</td> <td>-</td> <td>IS: 733</td> </tr> <tr> <td>Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)</td> <td>-</td> <td>IS: 1285</td> </tr> <tr> <td>Steel doors, windows, and ventilators</td> <td>-</td> <td>IS: 1038</td> </tr> <tr> <td>Steel windows for industrial, building</td> <td>-</td> <td>IS: 1361</td> </tr> <tr> <td>Aluminium doors windows, and ventilators</td> <td>-</td> <td>IS: 1948</td> </tr> <tr> <td>Aluminium windows for industrial buildings</td> <td>-</td> <td>IS: 1949</td> </tr> <tr> <td>Steel doorframes</td> <td>-</td> <td>IS: 4351</td> </tr> <tr> <td>Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.</td> <td>-</td> <td>IS: 1081</td> </tr> <tr> <td>Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type</td> <td>-</td> <td>IS: 3614</td> </tr> <tr> <td>Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification</td> <td>-</td> <td>IS: 7452</td> </tr> </table>	Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733	Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285	Steel doors, windows, and ventilators	-	IS: 1038	Steel windows for industrial, building	-	IS: 1361	Aluminium doors windows, and ventilators	-	IS: 1948	Aluminium windows for industrial buildings	-	IS: 1949	Steel doorframes	-	IS: 4351	Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081	Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614	Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452	
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Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452																														
6.00.00	RATES AND MEASUREMENT																															
6.01.00	Rates Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.																															



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 11 OF 15

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00

Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition frames shall be in Kg. Panelling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005			
VOLUME - II B			
SECTION - D		SUB-SECTION - D5	
REV.NO.	00	DATE	09/04/2018
SHEET	12	OF	15

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors
 - i) 100 mm brass butt hinges with screws - 3 Nos.
 - ii) 150 mm brass tower bolts with screws - 1 No.
 - iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.
 - iv) 30 mm brass ring pull handle with Plates and screws - 1 No.
 - v) 150 mm brass coat hook with screws - 1 No.
 - vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door
 - i) Concealed hanging arrangement for door leaves.
 - ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.
 - iii) Heavy duty, cylinder look on active leaf.
 - iv) Pull handle of approved design on both leaves.
 - v) Doors stops for both leaves.
 - vi) Overhead door closure for both leaves.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 13 OF 15

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

- i) 100 mm butt hinges - 3 Nos. on each leaf.
- ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom)
On inside of inactive
Leaf. 1. No. (Top only)
On inside active leaf.
- iii) 200 mm anodized aluminum
pull handle - 1 No. of each leaf.
- iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

- i) 100 mm butt hinges - 3 Nos.
- ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside
face
- iii) 200mm anodised aluminum
Pull handle - 1 No.
- iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) 12" peg stays - 1 No. per leaf



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005
VOLUME - II B
SECTION - D | SUB-SECTION – D5
REV.NO. 00 DATE 09/04/2018
SHEET 14 OF 15

ANNEXURE-A

- iii) 2 point handles - 1 No. per leaf
- b) Top Hung Ventilators (Projecting Out)
 - i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
 - ii) Adjustable sliding fabrication assemblies - 2 Nos. per leaf.
 - iii) 2 point handles - 1 No. per leaf.
- c) Bottom Hung Ventilators (Projecting in)
 - i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
 - ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.
 - iii) Spring Catch - 1 No. per leaf.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 09/04/2018

SHEET 15 OF 15

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.

(As per IS-1948 latest editions)

a) Side Hung Windows

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) 300 mm peg stays - 1 No per leaf
- iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) Adjustable sliding fabrication assemblies - 2 Nos. per leaf
- iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) Concealed side arms for opening adjustment - 2 Nos. per leaf
- iii) Spring Catch - 1 No. per leaf



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION – D6

REV.NO. 00 DATE 09/04/2018

SHEET 1 OF 5

VOLUME: II B

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006



Bharat Heavy Electricals Limited

Project Engineering Management

PPEI Building, Power Sector,

Plot No. 25, Sector 16A,

Noida (U.P.)-201301



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION - D6

REV.NO. 00 DATE 09/04/2018

SHEET 2 OF 5

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	I.S. CODES	4
5.00.00	RATES	5

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR GLASS AND GLAZING	SPECIFICATION NO. PE-TS-999-600-C006 VOLUME - II B SECTION - D SUB-SECTION – D6 REV.NO. 00 DATE 09/04/2018 SHEET 3 OF 5
<u>GLASS AND GLAZING</u> 1.00.00 SCOPE This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications. 2.00.00 INSTALLATION 2.01.00 General The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, 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. Materials a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing. b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick. 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 required. d) Obscure glasses 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. g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation. 2.03.00 Glazing, Setting, and Finish All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.		



TITLE:

TECHNICAL SPECIFICATION FOR GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION - D6

REV.NO. 00 DATE 09/04/2018

SHEET 4 OF 5

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 glass pane, 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 mouldings 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.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00

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 leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00

I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION - D6

REV.NO. 00 DATE 09/04/2018

SHEET 5 OF 5

5.00.00

RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D SUB-SECTION – D7

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 5

VOLUME: II B

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-999-600-C007



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



TITLE:
**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007
VOLUME - II B
SECTION - D SUB-SECTION – D7
REV.NO. 00 DATE 30/11/2015
SHEET 2 OF 5

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D SUB-SECTION - D7

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 5

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 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 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, 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 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm 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.
- 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.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional 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 prescribed by the Engineer.

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS	SPECIFICATION NO. PE-TS-999-600-C007	
		VOLUME - II B	
		SECTION - D	SUB-SECTION – D7
		REV.NO. 00	DATE 30/11/2015
		SHEET 4	OF 5
		i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and 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 in 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 galvanized and with all ends rounded to assure smooth operation and hand protection.	
		k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.	
		2.02.00 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 opening up to 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 desired by the Engineer.	
2.03.00	Power operated Shutters/Grills These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.		
2.04.00	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.		
2.05.00	Erection Door shall be installed by the manufacturer or his authorized 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		

 Maharatna Company	TITLE:	SPECIFICATION NO. PE-TS-999-600-C007			
	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS	VOLUME - II B			
		SECTION - D		SUB-SECTION – D7	
		REV.NO.	00	DATE	30/11/2015
		SHEET	5	OF	5
in strict accordance with the latest Indian Electricity Rules.					
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE				
3.01.00	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.					
3.02.00	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.					
3.03.00	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.					
4.00.00	I.S. CODE				
IS: 6248 - Metal rolling shutters and rolling grills.					
5.00.00	RATES AND MEASUREMENT				
5.01.00	Rates				
Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.					
5.02.00	Measurement				
Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.					



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008			
VOLUME - II B			
SECTION - D		SUB-SECTION – D8	
REV.NO.	00	DATE	09/04/2018
SHEET	1	OF	9

VOLUME: II B

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-999-600-C008



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



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008
VOLUME - II B
SECTION - D SUB-SECTION - D8
REV.NO. 00 DATE 09/04/2018
SHEET 2 OF 9

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	7
4.00.00	IS CODES	8
5.00.00	RATES AND MEASUREMENTS	8



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008
VOLUME - II B
SECTION - D SUB-SECTION - D8
REV.NO. 00 DATE 09/04/2018
SHEET 3 OF 9

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 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.

2.01.02 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 IS: 816.
- c) Welding of aluminium shall be done 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.

2.01.03 Shop Coat

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. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

 Maharatna Company	TITLE:	SPECIFICATION NO. PE-TS-999-600-C008			
	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL SIDING	VOLUME - II B			
		SECTION - D		SUB-SECTION – D8	
		REV.NO.	00	DATE	09/04/2018
		SHEET	4	OF	9
2.02.00	Erection				
2.02.01	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.				
2.02.02	Temporary Bolting-Up				
	As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.				
2.02.03	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.				
2.02.04	Welding				
	Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.				
2.02.05	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.				
2.02.06	Drifting				
	Correction 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 weakness 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				



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008			
VOLUME - II B			
SECTION - D		SUB-SECTION - D8	
REV.NO.	00	DATE	09/04/2018
SHEET	5	OF	9

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.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 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 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008			
VOLUME - II B			
SECTION - D		SUB-SECTION - D8	
REV.NO.	00	DATE	09/04/2018
SHEET	6	OF	9

nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION - D8

REV.NO. 00 DATE 09/04/2018

SHEET 7 OF 9

sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02

Barbed Wire Fencing

The barbed wire shall be conform to IS:278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008
VOLUME - II B
SECTION - D SUB-SECTION – D8
REV.NO. 00 DATE 09/04/2018
SHEET 8 OF 9

to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as 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 blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanised Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanised Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASUREMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items. Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008			
VOLUME - II B			
SECTION - D		SUB-SECTION – D8	
REV.NO.	00	DATE	09/04/2018
SHEET	9	OF	9

5.02.0

Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



**TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 12

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009



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



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 12

C O N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	6
4.00.00	I.S. CODES	10
5.00.00	RATES AND MEASUREMENTS	11

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without

loose grains and free from any dull, chalky, or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 12

segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 12

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. The pattern of laying and number of layers shall be as per Schedule of item. 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.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. 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.

3.02.00 Brick-on-Edge

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.

3.03.00 Masonry

3.03.01 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.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

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 without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 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.

3.03.04 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 brickwork shall be cleaned at the end of days work. If face bricks are specified, 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.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 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.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. 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. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 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.

3.03.09 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 and specified. 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 waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 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 Carborundum stone.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 9 OF 12

3.03.11 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.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 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.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 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.

3.05.00 Damp Proof Membrane

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 shown as drawings or as specified. 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, at his own expense, 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.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall

TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 10 OF 12

consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 11 OF 12

4.00.00

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.

5.00.00

RATES AND MEASUREMENTS

5.01.00

Rates

Unit rate for masonry work shall include the following:

- a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- b) Preparing top sand sides of existing wall for joining old with new work.
- c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00

Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE : 30/11/2015

SHEET 12 OF 12

- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.
- d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;
- e) Chases of section not exceeding 50 cm in girth;
- f) Iron fixtures, such as wall ties and hold fasts for doors and windows;
- g) Cement concrete blocks as for hold fasts and holding down bolts;
- h) Wall plates, bed plates, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.



**TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND CONCRETE**

SPECIFICATION NO. PE-TS-999-600-C010			
VOLUME - II B			
SECTION - D		SUB SECTION - D10	
REV.NO.	0	DATE : 30/11/2015	
SHEET	1	OF	9

VOLUME: II B

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010



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



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010	
VOLUME - II B	
SECTION - D	SUB SECTION - D10
REV.NO. 0	DATE : 30/11/2015
SHEET 2	OF 9

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	I.S. CODE	8
5.00.0	RATES AND MEASUREMENTS	9



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, 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 minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 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 rushed 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 of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

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



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 9

working consistency. The sand for plaster shall conform to IS: 1542.

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.

2.02.02 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, without any extra cost to the Owner, 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.

2.02.03 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, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 9

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 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat 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 editions.

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 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm 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 oil 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 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 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 9

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.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04

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.

2.03.00

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 finishes with suitable tools to shape as shown on



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 7 OF 9

the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 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 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 and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 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 punting 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.

2.06.00 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. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 8 OF 9

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 drawings 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 non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (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.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

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 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: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE : 30/11/2015

SHEET 9 OF 9

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	1	OF	13

VOLUME: II B

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011



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



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
VOLUME - II B
SECTION - D SUB-SECTION - D11
REV.NO. 00 DATE 30/11/2015
SHEET 2 OF 13

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND TESTING	10
4.00.00	I.S. CODES AND STANDARDS	11
5.00.00	RATES AND MEASUREMENTS	12



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION – D11	
REV.NO.	00	DATE	30/11/2015
SHEET	3	OF	13

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, 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.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 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 and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. 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 finished coats to be applied.

All unspecified materials such as snellac, 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 recognized manufacturers and shall be approved by the Engineer.

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.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	4	OF	13

a) White Wash/Colour Wash

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 editions. 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 for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

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 rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). 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 soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	5	OF	13

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not 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) Varnishing

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 woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 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.

2.01.00 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.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION - D11
 REV.NO. 00 DATE 30/11/2015
 SHEET 6 OF 13

2.01.02 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 shellace 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.

2.01.02 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 patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing 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:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized 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. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D

SUB-SECTION – D11

REV.NO. 00

DATE 30/11/2015

SHEET
7

7

OF

13

2.02.00 Application

2.02.01 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 used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to 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 undercoat 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 production of good results. No painting shall be done when plastering is in progress or is 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 I & 2).
The total dry thickness of film should not be less than 120 Micron.

2.02.02 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 white washing.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	8	OF	13

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 the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 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 solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 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.

2.02.05 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.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. 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 done strictly as per manufacturer's specification.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION – D11
 REV.NO. 00 DATE 30/11/2015
 SHEET 9 OF 13

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primed 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.

2.02.08 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.

2.02.09 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 white 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 begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted 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.

2.02.10 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 shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	10	OF	13

After application of the filler paste, the French polish shall be applied with a pad of woollen 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.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment 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.

2.04.00 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 splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

- 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.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION - D11
 REV.NO. 00 DATE 30/11/2015
 SHEET 11 OF 13

Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00

I.S. CODE

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 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: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.



TITLE:
**TECHNICAL SPECIFICATION FOR
 PAINTING, WHITEWASHING,
 POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011			
VOLUME - II B			
SECTION - D		SUB-SECTION - D11	
REV.NO.	00	DATE	30/11/2015
SHEET	12	OF	13

- IS: 2338 Code of Practice for finishing of wood and wood based materials.
 (I & II)
- 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, exterior type-1.
- IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D

SUB-SECTION - D11

REV.NO. 00

DATE 30/11/2015

SHEET 13

OF 13



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 1 OF 22

VOLUME: II B

SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C012



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



TITLE:
**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012
VOLUME - II B
SECTION - D | SUB-SECTION – D12
REV.NO. 00 DATE 09/04/2018
SHEET 2 OF 22

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	4
3.00.00	ACCEPTANCE CRITERIA	20
4.00.00	I.S. CODES	21
5.00.00	RATES AND MEASUREMENTS	21



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 3 OF 22

FLOOR FINISH AND ALLIED WORKS

1.00.0

SCOPE

This section 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) Terrazzo finish
- iii) Granolithic finishes
- iv) Patent Stone
- v) Metallic Hardener like “Ironte”/Hardonate Finish
- vi) Mastic Asphalt finishes
- vii) Chemical Resistant finish

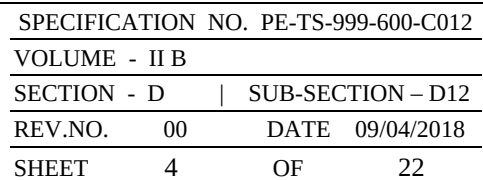
b) Tiled Finishes

- i) Terrazzo tile
- ii) Chequered tile
- iii) Glazed tile
- iv) Tesse rae (Mosaic etc.)
- v) Chemical Resistant
- vi) Rubber, Vinyl etc.
- vii) Stone Slab including Kota Stone.

1.01.00

Base

The base to receive the finish is covered under other relevant specifications.





TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 5 OF 22

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 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' 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 lying.

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.

2.01.02 Terrazzo Finish in Situ

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 out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to attain 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 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 6 OF 22

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 gray 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 1½ 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 shall 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.

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 underbeds 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 an even pattern of distribution.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 7 OF 22

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 Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) 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. A suitable machine shall do the grinding. 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 polishing shall be postponed 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.

2.01.03

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 8 OF 22

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 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 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 the 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 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

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 pounding 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 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

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 per



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 9 OF 22

approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04

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 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size 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.

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 leveled 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 be 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 10 OF 22

2.01.05

Metallic Hardener Like 'Ironite'/'Hardonate' 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 required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brush as soon as possible.

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 smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 11 OF 22

2.01.06 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 grade 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 limestone 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 IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg 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 leveled 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.

The mastic shall be laid in suitable panels of about 1.5 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 12 OF 22

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. 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 specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 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.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo 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 trademark 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 pinholes 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.

**TITLE:****TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 13 OF 22

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 gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (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



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 14 OF 22

in advance and approval of the Engineer taken.

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 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02

Chequered Tile Finish

The finish shall consist of manufactured gray 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 2.02.01 (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 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 15 OF 22

2.02.03

Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm 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 5.5 mm to 6 mm on 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 textures, 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.

c) Laying

Same as clause 2.02.01 (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



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 16 OF 22

suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04

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.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 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 2.02.03 (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 2.02.03 (d) shall generally be followed. However, instead of gray 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 17 OF 22

2.02.05 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 shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

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 these tiles shall be durable, strong and chemical resistant epoxy mortar. 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.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an 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 as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 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 trademark, the thickness, sizes, batch number, and date of

**TITLE:****TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 18 OF 22

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.

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: 3 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 19 OF 22

2.02.07

Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and 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 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed 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, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 09/04/2018

SHEET 20 OF 22

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 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08

Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling 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. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00

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

	TITLE: TECHNICAL SPECIFICATION FOR FLOOR FINISH AND ALLIED WORKS	SPECIFICATION NO. PE-TS-999-600-C012 VOLUME - II B SECTION - D SUB-SECTION – D12 REV.NO. 00 DATE 09/04/2018 SHEET 21 OF 22
4.00.00	I.S. CODES 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 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: 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. 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.	
5.00.00	RATES AND MEASUREMENT	
5.01.00	Rates	
	Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc. Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.	



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 09/04/2018

SHEET 22 OF 22

5.02.00

Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.



TITLE:

**TECHNICAL SPECIFICATION FOR
SHEET WORK IN ROOF AND
SIDING**

SPECIFICATION NO. PE-TS-999-600-C013

VOLUME - II B

SECTION - D | SUB-SECTION – D13

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-999-600-C013



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



TITLE:

**TECHNICAL SPECIFICATION FOR
SHEET WORK IN ROOF AND
SIDING**

SPECIFICATION NO. PE-TS-999-600-C013

VOLUME - II B

SECTION - D | SUB-SECTION - D13

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	6

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 30/11/2015 SHEET 3 OF 6
<u>SHEET WORK IN ROOF AND SIDING</u> 1.00.00 SCOPE This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified. 2.00.00 INSTALLATION 2.01.00 Storage of Materials All materials shall be stored by the Contractor in proper way to prevent all damage. 2.02.00 Workmanship The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527. 2.02.01 Asbestos Sheeting Asbestos sheets of profiles as specified 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 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge cappings, corner pieces, ventilators, north light curves etc. 2.02.02 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 purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. 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 with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.		

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 30/11/2015 SHEET 4 OF 6
2.02.03 Fibre Glass Reinforced Plastic Sheeting This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. 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. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure. 2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM - Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF₂) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns. - Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm. - The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability. - Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap. - The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool. 2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM - Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having		

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 30/11/2015 SHEET 5 OF 6												
	minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF₂ paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability. ii. FLASHING, CAPS, TRIM CLOSURES ETC. All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding. 3.00.00 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. 4.00.00 I.S. CODE 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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table border="0" style="width: 100%;"> <tr> <td style="width: 20%;">IS: 3007</td> <td style="width: 10%;">:</td> <td>Code of practice for laying of asbestos cement sheets.</td> </tr> <tr> <td>IS: 2527</td> <td>:</td> <td>Code of practice for fixing rainwater gutters and down pipes for roof drainage.</td> </tr> <tr> <td>IS: 1626</td> <td>:</td> <td>Specification for asbestos cement building pipes, gutters and fittings.</td> </tr> <tr> <td>IS: 277</td> <td>:</td> <td>Specification for galvanized steel sheets (plain and corrugated).</td> </tr> </table>	IS: 3007	:	Code of practice for laying of asbestos cement sheets.	IS: 2527	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.	IS: 1626	:	Specification for asbestos cement building pipes, gutters and fittings.	IS: 277	:	Specification for galvanized steel sheets (plain and corrugated).	
IS: 3007	:	Code of practice for laying of asbestos cement sheets.												
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 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 30/11/2015 SHEET 6 OF 6
5.00.00	RATES AND MEASUREMENT 5.01.00 Rates Rates shall be unit rate for complete item described in “Schedule of Items” and shall include all wastage. 5.02.00 Measurement Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.	



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014



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



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6



TITLE:

TECHNICAL SPECIFICATION FOR SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION - D14

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 30/11/2015

SHEET 4 OF 6

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the “Schedule of items”. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

- a) Plaster of Paris board (decorative)
- b) Expanded polystyrene insulation board with plastic fascia.
- c) Fibre Insulation board.
- d) Bonded wooden particle board (Plain and decorative)
- e) Glass fibre reinforced polystyrene sheets.
- f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer’s instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be “Luxalon 84C ” or approved equal and the installation shall be strictly as per manufacturer’s instruction/ specification subject to approval of the Engineer.



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 30/11/2015

SHEET 5 OF 6

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-ordinated with all related work and shall show the following information:

- a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.
- b) Typical Intermediate framing for support where required.
- c) Hanger fastening details.
- d) Panels - unit support at ceiling penetrations.
- e) Details of splicing method for main and cross runners.
- f) A table indicating load bearing capacity of main and cross runner
- g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR SUSPENDED CEILING	SPECIFICATION NO. PE-TS-999-600-C014			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – D14	
		REV.NO.	00	DATE	30/11/2015
		SHEET	6	OF	6
5.00.00	ACCEPTANCE CRITERIA				
	Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.				
6.00.00	RATES AND MEASUREMENT				
6.01.00	Rates				
	Rates shall be for the complete item called for in the “Schedule of Items”. No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.				
6.02.00	Measurement				
	Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.				



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 23

VOLUME: II B

SECTION - D

SUB-SECTION – D15

**WATER SUPPLY, DRAINAGE
AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015



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



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 23

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIAL	3
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	17
5.00.00	I.S. CODES	20
6.00.00	RATE AND MEASUREMENT	21



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 23

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

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 orders 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 expansive 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.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 4 OF 23

- a) Cast Iron pipe
- b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)
- c) Concrete pipe
- d) Asbestos cement pipe
- e) PVC pipe
- f) Stoneware pipe
- g) Vitrified pipe
- h) Lead pipe (not to be used for portable water)

2.02.01

Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) European type

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 5 OF 23

plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) Squatting type

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

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.



TITLE:
**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015
VOLUME - II B
SECTION - D | SUB-SECTION – D15
REV.NO. 00 DATE 30/11/2015
SHEET 6 OF 23

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

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.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

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.

Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

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 normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 7 OF 23

shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. 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 pipelines, fittings, and fixtures shall be installed leak proof. 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.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. 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 spacing 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. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 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 watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other 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.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 8 OF 23

3.02.04 Underground Piping

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.

3.02.05 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, and 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.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. 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 one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement 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 down comers shall run along and be secured to walls, columns etc.

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION – D15 REV.NO. 00 DATE 30/11/2015 SHEET 9 OF 23
	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. 3.03.02 Khurras The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade. 3.03.03 Gutters The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. 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 sagging 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 riveting, 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. 3.04.00 SOIL AND DRAINAGE PIPES 3.04.01 Gradients If not specified the minimum gradients of soil and drainage pipeline shall be as follows:	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION – D15 REV.NO. 00 DATE 30/11/2015 SHEET 10 OF 23
	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 3.04.02 Relation with water supply pipelines Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines. 3.04.03 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. 3.04.04 Support and Protection of 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.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION - D15 REV.NO. 00 DATE 30/11/2015 SHEET 11 OF 23
	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. Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume. 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. 3.04.05 Entry into structures 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 pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended. 3.04.06 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. 3.04.07 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-	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION – D15 REV.NO. 00 DATE 30/11/2015 SHEET 12 OF 23
	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. 3.04.08 Manhole & Inspection Chambers At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashings 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. Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out. 3.04.09 Cutting of Pipes 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. 3.04.10 Jointing Jointing of 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 watertight 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 centred in the socket of the pipe by tightly caulking in sufficient	



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 13 OF 23

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 leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 14 OF 23

shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthenware trap connected to such a pan is to



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 15 OF 23

be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 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 hand packing 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 minimize inconvenience of traffic where applicable.

3.04.12 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 pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 16 OF 23

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from 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.

3.06.02 Effluent Disposal

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 SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. 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 brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.



TITLE:

TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 30/11/2015

SHEET
17
OF
23

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. 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.

3.06.05 Commissioning septic tank

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.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under 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.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 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.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 30/11/2015

SHEET 18 OF 23

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/sq.cm 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 watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 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 watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. 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:



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 19 OF 23

a) Smoke test

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 tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The 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 centimetre of diameter per kilometre 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 be 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.

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
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.



TITLE:
**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015
VOLUME - II B
SECTION - D | SUB-SECTION – D15
REV.NO. 00 DATE 30/11/2015
SHEET 20 OF 23

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. 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 in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

- IS: 404 : Lead pipes.
- IS: 407 : Brass tubes for general purposes.
- IS: 458 : Concrete pipes (with or without reinforcement)
- IS: 783 : Code of Practice for laying of concrete pipes.
- 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: 1230 : Cast iron rain water pipes and fittings.
- IS: 1239 : Specification for Mild Steel Tubes and Mild Steel
(Pt.I & III) Tubulars 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: 1592 : Asbestos cement pressure pipes,

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION – D15 REV.NO. 00 DATE 30/11/2015 SHEET 21 OF 23
	IS: 1626 : Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types). IS: 2065 : Code of Practice for Water Supply in buildings. IS: 2501 : Copper tubes for general engineering purposes. IS: 2556 : Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement IS: 2633 : Method of testing, uniformity of coating on zinc coated articles. IS: 3076 : Low density polyethylene pipes for portable water supplies. IS: 3486 : Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter). IS: 3589 : Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter). IS: 4827 : Specification for electro plated coatings of nickel and chromium on copper and copper alloy. IS: 4964 : High-density polyethylene pipes for portable water supplies. IS: 12701 : Rotational moulded polyethylene water storage tanks	
6.00.00	RATE AND MEASUREMENT	
6.01.00	RATE	
6.01.01	G.I. Pipes For Water Supply	
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.	
6.01.02	Rainwater Down-comers	
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.	



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 30/11/2015

SHEET 22 OF 23

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of "Schedule of Items". Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 30/11/2015

SHEET 23 OF 23

6.02.02

Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 36

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE



Maharatna Company

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 36

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	36
5.00.00	MEASUREMENT	36



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 36

**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.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 4 OF 36
1.04.00	Materials To Be Used 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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 5 OF 36

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	$\pm 15\text{ mm}$
Wearing course	$\pm 10\text{ mm}$

Tolerance in wearing course shall not be permitted in conjunction with the



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 6 OF 36

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
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6



TITLE:

TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 7 OF 36

8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

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

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 8 OF 36

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 9 OF 36

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 10 OF 36

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 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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 11 OF 36

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. 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 12 OF 36

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 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

**TITLE:****TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 13 OF 36

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.

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 14 OF 36

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 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

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 15 OF 36
	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 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.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 16 OF 36

**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 loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.



TITLE:

TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 17 OF 36

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

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 18 OF 36

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

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 20 OF 36

**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	100
		10.0 mm	90 - 100
		4.75 mm	10 - 30
		150 micron	0 - 8
B	10 mm	10 mm	100
		4.75 mm	85 - 100
		150 micron	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 shall be



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 21 OF 36

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 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 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 22 OF 36

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 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.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 23 OF 36
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 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	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 24 OF 36

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.

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

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 26 OF 36

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 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.

**TITLE:****TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 27 OF 36

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.

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 28 OF 36

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 29 OF 36

Table - XI

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 30/11/2015

SHEET 30 OF 36

c) Tack Coat

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 painted

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 31 OF 36
	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.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 32 OF 36

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 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



TITLE:

TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 33 OF 36

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 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

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 34 OF 36
	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. 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	

**TITLE:****TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 30/11/2015

SHEET 35 OF 36

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.

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.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 30/11/2015 SHEET 36 OF 36
	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.	



TITLE:

**TECHNICAL SPECIFICATION FOR
FABRICATION OF STRUCTURAL
STEEL WORK**

SPECIFICATION NO. PE-TS-999-600-C017

VOLUME - II B

SECTION - D

SUBSECTION -D17

REV.NO. 0

DATE 16/03/2016

SHEET 1

OF 40

VOLUME: II B

SECTION - D (PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK



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



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STEEL WORK**

SPECIFICATION NO. PE-TS-999-600-C017

VOLUME - II B

SECTION - D

SUBSECTION -D17

REV.NO. 0

DATE 16/03/2016

SHEET 2

OF 40

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	WORKMANSHIP	19
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	29
5.00.00	INFORMATION TO BE SUBMITTED	33
6.00.00	RATES AND MEASUREMENTS	34

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 3 OF 40
SUB-SECTION – D XVII FABRICATION OF STRUCTURAL STEEL WORK 1.00.00 SCOPE This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract. 2.00.00 GENERAL 2.01.00 Work to be provided for by the Contractor The work to be provided for by the Contractor, unless 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 the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval. 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 rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections, 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 Dispatch lists, Rivet and Bolt List and any other list of bought out items 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. i) Maintain a fully equipped workshop at site for fabrication, modification		

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 4 OF 40
	and repairs of steelwork at site as may be required to complete the works in accordance with the Contract. 2.02.00 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. 2.03.00 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: IS : 226 - Structural steel (Standard Quality) IS : 800 - Code of Practice for general construction in steel. IS : 806 - Code of practice for use of steel tubes in general building construction. IS : 808 - Rolled steel beams, channels, and angle sections IS : 813 - Scheme of symbols for welding IS : 814 - Covered electrodes for metal arc welding of structural steel IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels. IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel IS : 817 - Code of practice for training and testing metal arc welders IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations IS : 822 - Code of practice for inspection of welds IS : 919 - Recommendations for limits and fits for Engineering IS : 961 - Structural Steel (High Tensile)	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	16/03/2016
		SHEET	5	OF	40
IS : 1148 - Rivet bars for structural purposes IS : 1149 - High tensile rivet bars for structural purposes IS : 1161 - Steel Tubes for structural purposes IS : 1200 - Method of measurement of steelwork and ironwork (Part 8) IS : 1239 - Mild Steel Tubes IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm) IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia, range 6 to 39 mm) IS : 1367 - Technical supply conditions for threaded fasteners IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes. IS : 1731 - Dimensions for steel flats for structural and general engineering purposes IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products IS : 1977 - Structural steel (ordinary quality) St-42-0 IS : 2062 - Steel for General Structural Purposes IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming IS : 2595 - Code of Practice for Radiographic Testing IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles IS : 3757 - High strength structural bolts					

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 6 OF 40
	IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products IS : 7205 - Safety Code for Erection of Structural Steelwork IS : 7215 - Tolerances for fabrication of steel structures IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels. IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels. 2.04.00 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. 2.05.00 Materials to be used 2.05.01 General All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, 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 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 tones or less of any particular section. The arc welding electrodes shall be of approved reputed manufacture and conforming 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 container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 7 OF 40
2.05.02	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: a) IS : 2062 - Steel for general structural purposes b) IS : 961 - Structural steel High Tensile c) IS : 1977 - Structural steel (Ordinary quality) St-42-0 In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.	
2.05.03	Rivet Steel	
	All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable: a) IS : 1148 - Rivet Bars for structural purpose b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.	
2.05.04	Electrodes	
	All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable a) IS : 814 - Covered electrodes for metal arc welding of structural steel b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel d) IS : 7280 - Bare wire electrodes for submerged arc welding of	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 8 OF 40
structural steels 2.05.05 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 than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 $\sqrt{A}$, where "A" is the cross sectional area of the test specimen i) IS: 1367: Technical supply conditions for threaded fasteners ii) IS: 1608: Method for tensile testing of steel products 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. 2.05.06 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: a) IS : 2062 - Steel for general structural purposes b) IS : 961 - Structural Steel (High Tensile Quality) c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0 d) IS : 6649 - Hardened washers 2.05.07 Paints Paints to be used for shop coat of fabricated steel under the purview of this		

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 9 OF 40
	contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming. 2.06.00 Coal Bin 2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal. 2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.I & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments. 2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face. 2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process. 2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing. 2.07.00 New Erection Marks 2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work. 2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter. 2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 10 OF 40
2.08.00	ELECTRO FORGED STEEL GRATINGS	
2.08.01	Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.	
2.08.02	All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.	
2.08.03	The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.	
2.08.04	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.	
2.08.05	Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.	
2.08.06	The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.	
2.08.07	Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.	
2.08.08	Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.	
2.08.09	Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 12 OF 40																					
	these defects noticed on visual or microscopic inspection shall render the material liable to rejection. 2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633. 2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose. 2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection. 2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains. 2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner. 2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item) 2.10.01 Material In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed. Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used. <table> <thead> <tr> <th>Material</th><th>%</th><th>Remarks</th></tr> </thead> <tbody> <tr> <td>Carbon</td><td>10.03%</td><td>Max.</td></tr> <tr> <td>Silicon</td><td>1.60%</td><td>Max.</td></tr> <tr> <td>Manganese</td><td>0.80% to 1.50%</td><td></td></tr> <tr> <td>Phosphorous</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Sulphur</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Chromium</td><td>10.80% to 12.50%</td><td></td></tr> </tbody> </table>	Material	%	Remarks	Carbon	10.03%	Max.	Silicon	1.60%	Max.	Manganese	0.80% to 1.50%		Phosphorous	0.03%	Max.	Sulphur	0.03%	Max.	Chromium	10.80% to 12.50%		
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 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 13 OF 40															
	Nickel 1.50% Max. Titanium 0.75% Max. Nitrogen 0.03% Max. The mechanical properties shall be as follows: <table> <tr> <th>Description</th> <th>Value</th> <th>Remarks</th> </tr> <tr> <td>Hardness Rock Well B Scale</td> <td>90</td> <td>Max.</td> </tr> <tr> <td>Tensile Strength</td> <td>450 MPa</td> <td>Min.</td> </tr> <tr> <td>Yield Strength</td> <td>300 MPa</td> <td>Min.</td> </tr> <tr> <td>Elongation</td> <td>25%</td> <td>Min.</td> </tr> </table>	Description	Value	Remarks	Hardness Rock Well B Scale	90	Max.	Tensile Strength	450 MPa	Min.	Yield Strength	300 MPa	Min.	Elongation	25%	Min.	
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2.10.02	Fabrication The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.																
2.10.03	Fabrication Drawings a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints. b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum																

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 14 OF 40
	procurement rate for the weight of stainless steel pieces not returned to the store. c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above. 2.10.04 Cuffing Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded. 2.10.05 Jointing Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test. 2.10.06 Bending The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile. 2.10.07 Welding sequence The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer. 2.10.08 Acceptance Criteria of Fabricated Structures The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 15 OF 40
	test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215. 2.11.00 BEARINGS 2.11.01 PTFE (Poly tetra fluorethylene) slide bearing a) General The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm. b) Material PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm. The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm². c) Installation The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 16 OF 40
	with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed. 2.12.00 Storage of material 2.12.01 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 and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date 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. 2.12.02 Steel The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise 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. 2.12.03 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. 2.12.04 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. 2.12.05 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.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 17 OF 40
2.13.00	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 free of cost 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. The quality control procedure shall cover but not be limited to the following items of work a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used. b) Rivets, Bolts, : Manufacturer's certificate, dimension checks, Nuts & Washers material testing. c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating. d) Welders : Qualifying Tests e) Welding sets : Performance Tests f) Welds : Inspection, X-ray, Ultrasonic tests g) Paints : Manufacturer's certificate, physical inspection reports h) 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.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 19 OF 40
	including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, 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 fabrication 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 carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract. 3.00.00 WORKMANSHIP 3.01.00 Fabrication 3.01.01 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 general construction in steel and other relevant Indian Standards or equivalent. 3.01.02 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 on IS: 1552 - 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°C. 3.01.03 Cutting Shearing, cropping, or sawing shall affect cutting. 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.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 20 OF 40
	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 gouges 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. 3.01.04 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. 3.01.05 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 web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided. 3.02.00 Riveted and bolted construction 3.02.01 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 rivet or 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 rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or 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 BS as specified in IS: 919. Parts to be connected shall be firmly held together by	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 21 OF 40
	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 rivets or bolts shall not be formed by gas cutting process. 3.02.02 Assembly All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. 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 rivets or 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 not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained. Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C. Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required. Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole. All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 22 OF 40
	Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary. 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 shown on drawing or directed by the Engineer. 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 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. 3.03.00 Welded Construction 3.03.01 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. 3.03.02 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. 3.03.03 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°). The work shall be positioned for flat welding whenever practicable.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 24 OF 40
	the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°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 hand warm. 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°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard. 3.03.13 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. 3.03.14 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 capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer. 3.04.00 Finish Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting 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 of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm. 3.05.00 Slab bases and caps Bases and caps fabricated out of steel slabs, except when cut 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.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 25 OF 40
	3. 12.00 Lacing bars The ends of lacing bars shall be neat and free from burns. 3. 13.00 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. 3.14.00 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. 3.15.00 Floor Grating All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used. The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer. The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width. Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm. 3.10.00 Chequered Plates Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 26 OF 40
	3.11.00 Architectural Clearances Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances. 3.11.00 Shop connections a) All shop connections shall be otherwise riveted or welded as specified on the Drawings. b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection. c) 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 at no extra cost to the exchequer. 3.13.00 Castings Steel castings shall be annealed. 3.14.00 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 dispatch. 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 interchange ability.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 29 OF 40
	erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer. 4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY 4.01.00 Inspection Unless specified otherwise, inspection to all, work shall be made by the 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 free of charge, 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. 4.02.00 Testing and Acceptance Criteria 4.02.01 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. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test. 4.02.02 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. Cost of all tests shall be born by the contractor. All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 30 OF 40
4.02.02	Welding a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc. b) Non-destructive examination shall be carried out to determine soundness of weldments as follows: i) 10% at random on fillet-joints. ii) 100% on all butt-joints. c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs. d) All electrodes shall be procured from approved reputed 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 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.	
4.02.04	Rivets, bolts, nuts and washers All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm 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. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.	
4.02.05	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.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 31 OF 40
	4.02.12 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 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products. 4.03.00 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 shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures. 4.04.00 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 some of the tests at an appropriate laboratory at the contractors cost. 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 acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. 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. 4.05.00 Delivery of materials 4.05.01 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.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 32 OF 40
	4.05.02 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. 4.05.03 Shipping Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. 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 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	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 33 OF 40
	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 packing 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 at no additional cost to the Owner. 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 bills of the Contractor. Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance. 5.00.00 INFORMATION TO BE SUBMITTED 5.01.00 With Tender The following information is 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. i) Preparation and approval of fabrication drawing ii) Procurement of Materials iii) Fabrication and shipping of all anchor bolts iv) Fabrication and shipping of main steelwork. v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 34 OF 40
	as applicable. vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork. vii) Final date of completion of all shipments. 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. 5.02.00 After Award After award of the Contract the successful Tenderer is to submit the following: a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him 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 o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information. c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials. d) Results of any test as and when conducted and as require by the engineer. e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable. 6.00.00 RATES AND MEASUREMENT 6.01.00 Rates 6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 35 OF 40
	operations described in the Specifications. 6.01.02 The bidder's rates shall include cost of all 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. Rates shall also include for taking all safety measures. 6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work. 6.01.04 No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings. 6.01.05 Rates shall be inclusive of all leads and lifts/elevation. 6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work. The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site. Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ. 6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.	

	TITLE:		SPECIFICATION NO. PE-TS-999-600-C017	
	TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK		VOLUME - II B	
			SECTION - D	SUBSECTION -D17
			REV.NO. 0	DATE 16/03/2016
			SHEET 37	OF 40
6.01.15	The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.			
6.01.16	The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.			
6.01.17	The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.			
6.01.18	The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.			
6.01.19	The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.			
6.02.00	MODE OF MEASUREMENT			
6.02.01	The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the			

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 38 OF 40
	foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer. 6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below. 6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section. 6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06. 6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made). 6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment. 6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m. 6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment. 6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment. 6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 39 OF 40
	welding/bolting. 6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds. 6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units. 6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer. 6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below 6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured. 6.02.20 For the work of addition to, alteration in and / or modification of 'erection	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 16/03/2016 SHEET 40 OF 40
	marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark. 6.02.21 For re-erection the weight of the modified erection mark shall only be measured. 6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel. 6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings. 6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate. 6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer. 6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION – D18

REV.NO. 0 DATE 30/11/2015

SHEET 1 OF 17

VOLUME: II B

**SECTION - D
(PART I)**

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D

SUBSECTION - D18

REV.NO. 0

DATE 30/11/2015

SHEET 2

OF 17

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	WORKMANSHIP	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	12
5.00.00	INFORMATION TO BE SUBMITTED	16

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018			
		VOLUME - II B			
		SECTION - D		SUBSECTION – D18	
		REV.NO.	0	DATE	30/11/2015
		SHEET	3	OF	17

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

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

2.00.00 GENERAL

2.01.00 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 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, riveting, 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 rectified with Engineer's approval. 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, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.
- g) All minor modifications of the fabricated steel structures as directed by the



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION – D18

REV.NO. 0 DATE 30/11/2015

SHEET 4 OF 17

Engineer including but not limited to the following:

- 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 rivet or bolt if required.
- iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
- v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- vii) Carry out tests in accordance with this specification.

2.02.00

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.

2.03.00

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 main or reinforced concrete.

2.04.00

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 sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions of the Engineer.

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 30/11/2015 SHEET 5 OF 17
	2.05.00 Material 2.05.01 General All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore. 2.05.02 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. 2.06.00 Storage of Materials 2.06.01 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 and the cost incurred thereof shall be realised from the Contractor's dues. 2.06.02 Yard The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and 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 must 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 at his own cost as directed by the Engineer. 2.06.03 Covered Store All field connection materials, paints, cement etc. shall be stored on well	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 30/11/2015 SHEET 6 OF 17
	designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor. 2.07.00 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 : i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts. ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout. iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats. 2.08.00 Taking Delivery The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him. The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge. 3.00.00 WORKMANSHIP 3.01.00 Erection 3.01.01 Plant and Equipment The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 7 OF 17

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, 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.

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 free of cost to the Owner.

The requirement 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.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 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 bylaws of state, Municipal or other local authorities.

3.01.05 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. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

**TITLE:****TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D

SUBSECTION - D18

REV.NO. 0

DATE 30/11/2015

SHEET 8

OF

17

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

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

3.01.06**Field Riveting**

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07**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.

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-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 9 OF 17

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times 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 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 (See Note below the Table). 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.

TABLE-II

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

Note: The above torque values are approximate for providing tensions of 14.

**TITLE:****TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 10 OF 17

7 T for 20 mm dia.; and 21.2 T 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 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.

3.01.08 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.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, 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, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 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

**TITLE:****TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 11 OF 17

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.

3.03.00**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.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, 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.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00**Painting after Erection**

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost 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

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 30/11/2015 SHEET 12 OF 17
	steelwork applicable for the project. Painting shall not be done in frosty 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 rivets, 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 Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted. The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved “Schedule of Painting”. The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932. 3.05.00 Final cleaning up Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work. 4.00.00 TESTING AND ACCEPTANCE CRITERIA 4.01.00 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 as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. 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 free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 13 OF 17

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 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, 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 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 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 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 the 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.

4.01.03 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.



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 30/11/2015

SHEET 14 OF 17

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.

4.01.04 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 4.01.01 hereinbefore.

4.02.00 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 steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	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	

 Maharatna Company	TITLE:	SPECIFICATION NO. PE-TS-999-600-C018			
	TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	VOLUME - II B			
		SECTION - D		SUBSECTION – D18	
		REV.NO.	0	DATE	30/11/2015
		SHEET	15	OF	17
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 10 M length measured between connection levels, but not more than ±7 mm per 30m length.			
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 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	3.0 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 greater than 10mm whichever is the least.			
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.			
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.			
	b) Deviation to crane rail-gauge	± 3.0 mm			

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018
		VOLUME - II B
		SECTION - D SUBSECTION – D18
		REV.NO. 0 DATE 30/11/2015
		SHEET 16 OF 17
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	Setting of Expansion gaps	d) Deviation of crane rail axis from centre line of web.
		± 3.5 mm
	iv) 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 lox 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.	
4.03.00	Acceptance Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.	
5.00.00	INFORMATION TO BE SUBMITTED	
5.01.00	Before Tender	
5.01.01	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.	

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C018	
	TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	VOLUME - II B	
		SECTION - D	SUBSECTION - D18
		REV.NO. 0	DATE 30/11/2015
		SHEET 17	OF 17
5.01.02	Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and 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.		
5.01.03	Erection Yard A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also 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.		
5.02.00	After award of the Contract After award of the contract, the Contractor shall submit the following:		
5.02.01	Detailed Programme The Contractor shall submit a detailed erection programme within a month of the award of the Contract 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 required strength of various categories of workers in a proforma approved by the Engineer.		
5.02.02	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 5.02.01 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.		



TITLE:

**TECHNICAL SPECIFICATION FOR
ROOF DECKING**

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION – D19

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 7

VOLUME: II B

SECTION - D

SUB-SECTION – D19

ROOF DECKING

SPECIFICATION NO. PE-TS-999-600-C019



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROOF DECKING**

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION – D19

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 7

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	3
4.00.00	ACCEPTANCE CRITERIA	6
5.00.00	IS CODES	6
6.00.00	RATES AND MEASUREMENTS	7



TITLE:

TECHNICAL SPECIFICATION FOR ROOF DECKING

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION - D19

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 7

ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets,

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 30/11/2015 SHEET 4 OF 7
	fixtures, flashings and trims. After approval he shall supply further eight copies. The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained. 3.02.00 Erection & Fixing 3.02.01 Sequence of Manufacture/Erection Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps. 3.02.02 Position and Location of Laps Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind. The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof. 3.02.03 Alignment of Sheets and Fixings All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds. 3.02.04 Site Cutting Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps. 3.02.05 Damaged Sheets Distorted, blemished or water stained sheets and any other fittings shall not be used.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019
		VOLUME - II B
		SECTION - D SUB-SECTION – D19
		REV.NO. 00 DATE 30/11/2015
		SHEET 5 OF 7
3.02.06	Laps End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.	
3.02.07	End Lap Fixings	
	End lap fixings shall be located at least 25 mm from the end of each sheet.	
3.02.08	Side Lap Fixings	
	The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.	
3.02.09	Holes	
	Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.	
3.02.10	Location and Spacing of Fixings	
	Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.	
3.02.11	Fixings	
	The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 30/11/2015 SHEET 6 OF 7
	recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets. 3.03.00 Protection during Construction Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times. 3.04.00 Damage Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer’s specification at no extra cost to the Owner. 4.00.00 Acceptance Criteria The installation 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 damage in the sheeting. c) Conformity of fixings with the approved design. 5.00.00 IS Codes 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 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 : 513 - Specification for cold rolled carbon steel sheets. IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion. IS : 4431 - Specification for carbon & carbon manganese free cutting steel. IS : 1573 - Electroplated Coatings of zinc on iron and steel.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROOF DECKING**

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION – D19

REV.NO. 00 DATE 30/11/2015

SHEET 7 OF 7

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

SPECIFICATION NO. PE-TS-999-600-C020



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



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	4
4.00.00	ACCEPTANCE CRITERIA	5
5.00.00	IS CODES	6
6.00.00	RATES AND MEASUREMENTS	6



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION - D20

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 6

FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of ± 0.2 mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of ± 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 30/11/2015

SHEET 4 OF 6

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FALSE FLOORING	SPECIFICATION NO. PE-TS-999-600-C020 VOLUME - II B SECTION - D SUB-SECTION – D20 REV.NO. 00 DATE 30/11/2015 SHEET 5 OF 6
	shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment. All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative. 3.03.00 Painting After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint. 3.04.00 Protection during Construction All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner. 3.05.00 Damage Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner. 4.00.00 ACCEPTANCE CRITERIA The false flooring system shall only be accepted after completion of following checks : - Level - Alignment of joints - Thickness of joints - Surface finish - Colour and texture - Details of edges, junctions etc. - Performance - Criteria specified for strength.	



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 30/11/2015

SHEET 6 OF 6

5.00.00 IS CODES

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 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:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION – D21

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 26

VOLUME: II B

SECTION - D

SUB-SECTION – D21

BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-999-600-C021



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



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 26

CONTENTS

CLAUSE NO.	DESCRIPTION	
1.00.00	SCOPE	3
2.00.00	GENERAL REQUIREMENTS	3
3.00.00	MATERIALS	5
4.00.00	PILE INSTALLATION	6
5.00.0	SAMPLING, TESTING, AND QUALITY ASSURANCE	12
6.00.00	PILE TESTING	15
7.00.00	CODES AND STANDARDS	16
8.00.00	RATES AND MEASUREMENT	17
	ANNEXURE-A	
	ANNEXURE-B	
	ANNEXURE-C	
	ANNEXURE-D	
	TABLE - 1	



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 3 OF 26

**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 REQUIREMENTS

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.



TITLE:

TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION – D21

REV.NO. 00 DATE 30/11/2015

SHEET
4
OF
26

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.

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 5 OF 26
	3.00.00 MATERIALS 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.	

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C021
	TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	VOLUME - II B
		SECTION - D SUB-SECTION - D21
		REV.NO. 00 DATE 30/11/2015
	SHEET 6 OF 26	

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 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 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.

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C021
	TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	VOLUME - II B
		SECTION - D SUB-SECTION - D21
		REV.NO. 00 DATE 30/11/2015
		SHEET 7 OF 26
4.01.03	The capacity of the rig shall be adequate so as to reach the specified founding level.	
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.	



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 8 OF 26

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.

- 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.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 9 OF 26
	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. 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).	

	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021	
		VOLUME - II B	
		SECTION - D	SUB-SECTION – D21
		REV.NO. 00	DATE 30/11/2015
		SHEET 10	OF 26
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.		
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.		

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 11 OF 26
	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 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.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 12 OF 26
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	
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	
	a) 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,	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 13 OF 26
	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. b) 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 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.	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021
		VOLUME - II B
		SECTION - D SUB-SECTION – D21
		REV.NO. 00 DATE 30/11/2015
		SHEET 14 OF 26
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	
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	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021
		VOLUME - II B
		SECTION - D SUB-SECTION – D21
		REV.NO. 00 DATE 30/11/2015
		SHEET 15 OF 26
	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 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	



TITLE:
**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021
VOLUME - II B
SECTION - D | SUB-SECTION - D21
REV.NO. 00 DATE 30/11/2015
SHEET 16 OF 26

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 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 foundations - Bored cast-in-situ concrete piles. Part I/Sec 2
- IS: 2911 - Code of practice for design and construction of pile foundation - Load test on piles. Part IV
- IS: 6926 - Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.
- IS: 10262 - Recommended guidelines for concrete mix design.

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021 VOLUME - II B SECTION - D SUB-SECTION – D21 REV.NO. 00 DATE 30/11/2015 SHEET 17 OF 26
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, 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,	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	SPECIFICATION NO. PE-TS-999-600-C021
		VOLUME - II B
		SECTION - D SUB-SECTION – D21
		REV.NO. 00 DATE 30/11/2015
		SHEET 18 OF 26
	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. 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.	



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 19 OF 26

- 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.
- 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.



TITLE:
**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021
VOLUME - II B
SECTION - D | SUB-SECTION – D21
REV.NO. 00 DATE 30/11/2015
SHEET 20 OF 26

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
a) Minimum length of the pile shall be _____* m below COL.
b) 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
a) 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.
b) 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



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 21 OF 26

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 22 OF 26

ANNEXURE-B

List of Equipments

SI.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.



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION – D21

REV.NO. 00 DATE 30/11/2015

SHEET 23 OF 26

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 24 OF 26

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 -

**TITLE:****TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021

VOLUME - II B

SECTION - D | SUB-SECTION - D21

REV.NO. 00 DATE 30/11/2015

SHEET 25 OF 26

14. SPT* N values in soil (from the nearest bore hole).
+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.



TITLE:
**TECHNICAL SPECIFICATION FOR
BORED CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-999-600-C021
VOLUME - II B
SECTION - D | SUB-SECTION – D21
REV.NO. 00 DATE 30/11/2015
SHEET 26 OF 26

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	



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 16

VOLUME: II B

SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

SPECIFICATION NO. PE-TS-999-600-C022



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



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 16

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15

	TITLE: TECHNICAL SPECIFICATION FOR SITE LEVELLING & GRADING WORKS	SPECIFICATION NO. PE-TS-999-600-C022 VOLUME - II B SECTION - D SUB-SECTION – D22 REV.NO. 00 DATE 30/11/2015 SHEET 3 OF 16
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.		



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 4 OF 16

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 5 OF 16

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

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 6 OF 16

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 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

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 7 OF 16

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 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.

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 8 OF 16

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

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.

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 9 OF 16

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.

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.

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 10 OF 16

* 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

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

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 11 OF 16

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

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.



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 00 DATE 30/11/2015

SHEET 12 OF 16

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

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

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 13 OF 16

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 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



TITLE:

**TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 14 OF 16

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, crosssections 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

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.

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C022
	TECHNICAL SPECIFICATION FOR SITE LEVELLING & GRADING WORKS	VOLUME - II B
		SECTION - D SUB-SECTION - D22
		REV.NO. 00 DATE 30/11/2015
		SHEET 15 OF 16

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.

d) 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.

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.

**TITLE:****TECHNICAL SPECIFICATION FOR
SITE LEVELLING & GRADING
WORKS**

SPECIFICATION NO. PE-TS-999-600-C022

VOLUME - II B

SECTION - D | SUB-SECTION – D22

REV.NO. 00 DATE 30/11/2015

SHEET 16 OF 16

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.



TITLE:

**TECHNICAL SPECIFICATION
FOR ANTI-TERMITE
TREATMENT**

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION – D23

REV.NO. 00 DATE 30/11/2015

SHEET 1 OF 5

VOLUME – II B

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023



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



TITLE:

**TECHNICAL SPECIFICATION
FOR ANTI-TERMITE
TREATMENT**

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION - D23

REV.NO. 00 DATE 30/11/2015

SHEET 2 OF 5

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	EXECUTION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	RATES	4
5.00.00	METHOD OF MEASUREMENT	4
6.00.00	I.S. CODES	5

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-999-600-C023											
		VOLUME - II B											
		SECTION - D		SUB-SECTION – D23									
		REV.NO.	00	DATE	30/11/2015								
		SHEET	3	OF	5								
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. <table><tr><td>Chemicals</td><td>Concentration by Weight, Percentage</td></tr><tr><td>Chlorpyrifos Emulsifiable (IS 8944 - 1978)</td><td>: 1.0</td></tr><tr><td>Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)</td><td>: 0.5</td></tr><tr><td>Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)</td><td>: 1.0</td></tr></table>					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
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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 / M ² of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M ² 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												

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-999-600-C023 VOLUME - II B SECTION - D SUB-SECTION – D23 REV.NO. 00 DATE 30/11/2015 SHEET 4 OF 5
	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 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.	



TITLE:

**TECHNICAL SPECIFICATION
FOR ANTI-TERMITE
TREATMENT**

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION – D23

REV.NO. 00 DATE 30/11/2015

SHEET 5 OF 5

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.