E-T E N D E R S P E C I F I C A T I O N

BHE/PW/PUR/NTPRT-BAL-CVL-BOP/2682

S. No.	E- TENDER SPECIFICATION NUMBER
01	BHE/PW/PUR/NTPRT-BAL-CVL-BOP/2682

FOR

CIVIL & ARCHITECTURAL WORKS OF BOP WORKS FOR FQA LAB, O&M STORE, CISF BUILDING, MAIN GATE COMPLEX ETC. AT 3X800 MW PVUNL PATRATU STPP JHARKHAND

VOLUME I E – Technical Specifications and Plot Plan

THIS TENDER SPECIFICATION CONSISTS OF:

Notice Inviting Tender	
Volume-IA	**Technical Conditions of Contract**
Volume-IB	**Special conditions of Contract**
Volume-IC	**General conditions of Contract**
Volume-ID	**Forms & Procedures**
Volume-IE	**Technical Specifications and Plot Plan**
Volume II	**Price Bid**

Bharat Heavy Electricals Limited
(*A Government of India Undertaking*)
Power Sector - Western Region
345-Kingsway, Nagpur-440001

E-T E N D E R S P E C I F I C A T I O N

BHE/PW/PUR/KNFGD-PILES-PKG-A/2393/PKG-B/2394

S. No.	E- TENDER SPECIFICATION NUMBER
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FOR

CIVIL & ARCHITECTURAL WORKS OF BOP WORKS FOR FQA LAB, O&M STORE, CISF BUILDING, MAIN GATE COMPLEX ETC. AT 3X800 MW PVUNL PATRATU STPP JHARKHAND

EARNEST MONEY DEPOSIT: Refer Notice Inviting Tender

LAST DATE FOR TENDER SUBMISSION: Refer Notice Inviting Tender

THESE TENDER SPECIFICATION DOCUMENTS CONTAINING VOLUME-I AND VOLUME- II ARE ISSUED TO:

M/s. ……

……

PLEASE NOTE:
THESE TENDER SPECS DOCUMENTS ARE NOT TRANSFERABLE.

For Bharat Heavy Electricals Limited

GM (Purchase)
Place: Nagpur
Date:

PATRATU SUPER THERMAL POWER STATION

3X800 MW, EXP STAGE-1

VOLUME: IIB

SECTION - C

SPECIFIC TECHNICAL REQUIREMNTS FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL

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PART-I : GENERAL CIVIL REQUIREMENT

PART-II : SPECIFIC DESIGN REQUIREMENTS - CIVIL

PART-I

GENERAL CIVIL REQUIREMENT

1. GENERAL

Two Volumes-Section C & Section D of this specification cover site survey, soil investigation, site development works, design and construction of Civil, Structural and Architectural works. The scope of works covers complete Civil, Structural and Architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the packages. This Part-I of Section-C Lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. **If there is any ambiguity and/or contradiction between Section C and Section D, the provisions / requirements laid in Section C shall prevail. In case of ambiguity between BOQ and Part C former shall prevail**.

(Contractor shall read the parts of the specification relevant to the contract and shall ignore the other parts of the specification. Relevant clauses of this section as applicable for respective package to be followed.)

2. CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/ Technical Specifications as appropriate. The latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

2.1. Earthwork

a) IS-1498: Classification and identification of soils for General Engineering purposes.
b) IS-3764: Safety Code for excavation work.
c) IS-7293: Safety Code for working with construction machinery.
d) IS-4701: Code of practice for earth work on canals.
e) IS-9759: Guide lines for dewatering during construction.
f) IS-10379: Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

2.2. Concrete

a) IS-269: Ordinary and low heat Portland cement.
b) IS-383: Coarse and fine aggregate from natural sources for concrete.
c) IS-432: (Part I & II) Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
d) IS-455: Portland Slag Cement.
e) IS-456: Code of Practice for Plain and reinforced concrete.
f) IS-457: Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
g) IS-460: Test Sieves (all parts).
h) IS-516: Methods of test for strength of concrete.
i) IS-1199: Methods of sampling and analysis of concrete.
j) IS-1566: Hard drawn steel wire fabric for concrete Reinforcement.
k) IS-1786: High strength deformed steel bars and wires for concrete Reinforcement.
l) IS-1791: General requirement for batch type concrete mixers.
m) IS-1834: Hot applied sealing compounds for joints in concrete.
n) IS-1838: Preformed fillers for expansion joints in concrete pavement and structures.

o) IS-2386: (Part I-VIII)	Methods of test for aggregates for concrete (all parts).
p) IS-2438:	Specification for roller pan mixers.
q) IS-2502:	Code of practice for bending and fixing of bars for concrete Reinforcement.
r) IS-2505:	Concrete vibrators - immersion type.
s) IS-2506:	General requirements for screed board concrete vibrators.
t) IS-2722:	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
u) IS-2750:	Steel scaffoldings.
v) IS-2751:	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
w) IS-3150:	Hexagonal wire netting for general purposes.
x) IS-3366:	Specification for pan vibrators.
y) IS-3370: (Part I-IV)	Code of practice for concrete structures for storage of liquids (all parts).
z) IS-3414:	Code of practice for design and installation of joints in buildings.
aa) IS-3558:	Code of practice for use of immersion vibrators for consolidating concrete.
bb) IS-4014: (Part I & II)	Code of practice for steel tubular scaffolding.
cc) IS-4656:	Form vibrators for concrete.
dd) IS-4925:	Concrete batching and mixing plant.
ee) IS-4948:	Welded steel wire fabrics for general use.
ff) IS-4990:	Plywood for concrete shuttering work.
gg) IS-5256:	Code of practice for sealing expansion joints in concrete lining on canals.
hh) IS-6452:	High Alumina Cement for Structural use.
ii) IS-6461:	Glossary of terms relating to cement concrete.
jj) IS-6494:	Code of practice for water proofing of underground reservoir and swimming pools.
kk) IS-6509:	Code of practice for installation of joints in concrete pavements.
ll) IS-7320:	Concrete slump test apparatus.
mm) IS-7861: (Part I & II)	Code of practice for extreme weather concreting.
nn) IS-8041:	Rapid Hardening Portland Cement.
oo) IS-8112:	High strength ordinary Portland Cement.
pp) IS-9012:	Recommended practice for shotcreting.
qq) IS-9103:	Admixtures for concrete.
rr) IS-9417:	Recommendations for welding cold worked bars for reinforced concrete construction.
ss) IS-10262:	Recommended guidelines for concrete mix design.
tt) IS-458:	Specification for precast concrete pipes.
uu) IS-3935:	Code of practice for composite construction.
vv) IS-4995:	Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials.
ww) IS-5525:	Recommendation for detailing of reinforced concrete works.
xx) IS-11384:	Code of practice for composite construction in structural steel and concrete.
yy) IS-11682:	Criteria for design of RCC staging for overhead water tanks.
zz) IS:12118:	Two parts polysulphide based sealants.
aaa) IS:12200:	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
bbb) IS:13311:	Non-destructive testing of concrete - methods of test.
Part I -	Ultrasonic pulse velocity.
Part II -	Rebound hammer.
ccc) IS-13920:	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

ddd) SP-16: Design codes for reinforced concrete to IS:456-1978.
eee) SP-23: Hand book of concrete mixes.
fff) SP-24: Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS: 456)
ggg) SP-34: Hand book on concrete reinforcement and detailing.
hhh) ACI-318: American Concrete Institute code for structural concrete.
iii) IS-280: Mild steel wire for general engineering purpose.
jjj) IS-10297: Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
kkk) IS-10505: Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
lll) IS-15658: Pre-cast concrete block for paving.

2.3. Foundations

a) IS-1080: Code of practice for Design and Construction of shallow foundations on soils (other than raft, ring and shell)
b) IS-1904: Code of practice for Design and Construction of foundations in soils: General Requirements
c) IS-2314: Steel sheet piling sections.
d) IS-2911: Code of practice for Design and Construction of Pile foundations (all parts).
e) IS-2950: Code of practice for design and construction of raft foundations.
f) IS-2974: Code of practice for design and construction of machine foundations.
g) IS-4091: Code of practice for Design and Construction of foundations for transmission line towers and poles
h) IS-6403: Code of practice for determination of Bearing capacity of Shallow foundations.
i) IS-8009: Code of practice for calculation of settlement of foundations: (all parts)
j) IS-9556: Code of practice for Design and Construction of diaphragm walls.
k) IS-11089: Code of practice for Design and Construction of ring foundation.
l) IS-12070: Code of practice for design and construction of shallow foundations on rocks.
m) IS-13301: Guidelines for vibration isolation for machine foundation.
n) ISO 10816: Criteria for assessing mechanical vibrations of machines.
o) ISO 1940: Criteria for assessing the st of balance of rotating rigid bodies.
p) DIN: EN13906-1: Helical compression spring made of round wire and rod: calculation and design of compression.
q) DIN: 2096 Helical compression spring out of round wire and rod: Quality requirements for hot formed compression spring.
r) DIN: 4024 Flexible supporting structures for machine with rotating machines.

2.4. Loading

a) IS-875: Code of practice for Structural safety of buildings - loading standards.
b) IS-1911: Schedule of unit weights of building materials.
c) IRC-6: Standard specifications & Code of practice for road bridges.

2.5.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.
p) IS-1905: Code of practice for structural use of unreinforced masonry.
q) IS-10440: Code of practice for construction of reinforced brick and reinforced brick concrete floors and roofs.
r) SP-20: Hand book on masonry design and construction.
s) IS-1489: Portland-pozzolana cement.
t) IS-1542: Sand for Plaster.
u) IS-12269: 53 grade ordinary Portland cement.
v) IS-12894: Specification for fly ash lime bricks.
w) IS-13757: Burnt clay fly ash building bricks.

2.6.Doors, Windows and Ventilators

a) IS-399: Classification of commercial timbers and their zonal distribution.
b) IS-883: Code of practice for design of structural timber in building.
c) IS-1003: Timber panelled and glazed shutters (all parts).
d) IS-1038: Steel doors, windows and ventilators.
e) IS-1081: Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
f) IS-1361: Steel windows for industrial buildings.
g) IS-2835: Transparent sheet glass for glazing and framing purposes.
h) IS-1948: Aluminium doors windows and ventilators.
i) IS-1949: Aluminium windows for industrial building.
j) IS-2191: Wooden flush door shutters (Cellular and hollow core type).
k) IS-2202: Wooden flush door shutters (solid core type).
l) IS-3103: Code of practice for Industrial ventilation.
m) IS-3548: Code of practice for glazing in buildings.
n) IS-3614: Fire check doors.
o) IS-4021: Timber door, windows and ventilator frames.
p) IS-4351: Steel door frames.
q) IS-6248: Metal rolling shutters and rolling grills.
r) IS-208: Door Handles.
s) IS:281: Mild steel sliding door bolts for use with padlocks.
t) IS-362: Parliament Hinges.
u) IS-419: Putty, for use on window frames.
v) IS-451: Technical supply conditions for wood screws.
w) IS-733: Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
x) IS-1285: Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
y) IS-1341: Steel butt hinges.
z) IS-1823: Floor door stoppers.
aa) IS-1868: Anodic coatings on Aluminium and its alloys.

bb) IS-2209: Mortice locks (vertical type)
cc) IS-2553: Safety glass.
dd) IS-3564: Door closers (Hydraulically regulated).
ee) IS-5187: Flush bolts.
ff) IS-5437: Figured, rolled and wired glass.
gg) IS-6315: Specification for floor springs (Hydraulically regulated) for heavy doors.
hh) IS-7196: Hold fast.
ii) IS-7452: Hot rolled steel sections for doors, windows and ventilators.
jj) IS-10019: Mild steel stays and fasteners.
kk) IS-10451: Steel sliding shutters (top hung type)
ll) IS-12823: Prelaminated particle boards.

2.7.Roof and Flooring

a) IS-2204: Code of practice for construction of reinforced concrete shell roof.
b) IS-3201: Criteria for the design and construction of precast concrete trusses.
c) IS-2210: Criteria for Design of R.C. shell structures and folded plates.
d) IS-809: Rubber flooring materials for general purposes.
e) IS-1195: Bitumen mastic for flooring.
f) IS-1196: Code of practice for laying bitumen mastic flooring.
g) IS-1198: Code of practice for laying, fixing and maintenance of linoleum floors.
h) IS-1237: Cement concrete flooring tiles.
i) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.
j) IS-2114: Code of practice for laying in situ terrazzo floor finish.
k) IS-2571: Code of practice for laying in situ cement concrete flooring.
l) IS-5491: Code of practice for laying in situ granolithic concrete floor topping.
m) IS-5766: Code of practice for laying burnt clay brick flooring.
n) IS-1197: Code of practice for laying of rubber floors.
o) IS-2441: Code of practice for fixing ceiling coverings.

2.8.Waterproofing

a) IS-1322: Bitumen felts for waterproofing and damp proofing.
b) IS-1346: Code of practice for waterproofing of roofs with bitumen felts.
c) IS-1609: Code of practice for laying damp proof treatment using bituminous felts.
d) IS-3036: Code of practice for laying lime concrete for a waterproofed roof finish.
e) IS-3037: Bitumen mastic for use in waterproofing of roofs.
f) IS-3067: Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
g) IS-3384: Bitumen primer for use in water proofing and damp proofing.
h) IS-4365: Code of practice for application of bitumen mastic for waterproofing of roofs.
i) IS-5318: Code of practice for laying of flexible PVC sheet and tile flooring.
j) IS-8042: White Portland cement.
k) IS-13755: Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
l) IS-13801: Chequered cement concrete tiles.

2.9.Soil Engineering

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

2.10. Water Supply, Drainage and Sewerage

a) IS-404: Lead pipes
b) IS-458: Concrete pipes
c) IS-651: Salt glazed stoneware pipes and fittings.
d) IS-771: Glazed fire-clay sanitary appliances (all parts).
e) IS-774: Flushing cisterns for water closets and urinals other than plastic cisterns.
f) IS-783: Code of practice for laying of concrete pipes.
g) IS-1172: Code of basic requirements for water supply, drainage and sanitation.
h) IS-1626: Asbestos cement building pipes, gutters and fittings (all parts).
i) IS-1742: Code of practice for building drainage.
j) IS-2064: Code of practice for selection, installation and maintenance of sanitary appliances.
k) IS-2065: Code of practice for water supply in buildings.
l) IS-2470: Code of practice for installation of septic tanks (all parts).
m) IS-3114: Code of practice for laying of Cast Iron pipes.
n) IS-4127: Code of practice for laying of glazed stoneware pipes.
o) IS-12251: Code of practice for Drainage of Building Basement.
p) IS-1200: Method of measurement: Laying of water and [Part- XVI] sewer lines including appurtenant items.
q) IS-1536: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r) IS-1537: Vertically cast iron pressure pipe for water, gas and sewage.
s) IS-3486: Cast iron spigot and socket drain pipes.
t) IS-5329: Code of practice for sanitary pipe work above ground for buildings.
u) IS-3076: Low density polyethylene pipes for potable water supplies.
v) IS-1538: Cast iron fittings for pressure pipes for water, gas and sewage.
w) IS-1230: Cast iron rainwater pipes and fittings.
x) IS-1729: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y) IS-784: Prestressed concrete pipes.
z) IS-1726: Cast iron manhole covers and frames.
aa) IS-5961: Cast iron grating for drainage purposes.
bb) IS-5219 (Part-I): "P" and "S" traps.
cc) IS-772: General requirements for enamelled cast iron sanitary appliances.
dd) IS-775: Cast iron brackets and supports for wash basins and sinks.
ee) IS-777: Glazed earthenware wall tiles.
ff) IS-2548: Plastic water closet seats and covers (all parts).
gg) IS-2527: Code of practice for fixing rainwater gutters and downpipes for roof drainage.
hh) IS-554: Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
ii) IS-778: Copper alloy gate, globe and check valves for water works purposes.
jj) IS-781: Cast copper alloy screw down bib taps & stop valves for water services.
kk) IS-782: Caulking lead.
ll) IS-1703: Copper alloy float valve for water supply fitting.
mm) IS-2326: Automatic flushing cisterns for urinals.
nn) IS-2556: Vitreous sanitary appliances (vitreous china).
oo) IS-3311: Waste plug and its accessories for sinks and wash basins.
pp) IS-3438: Silvered glass mirrors for general purposes.
qq) IS-3589: Steel pipe for water and sewage (168.3 to 2540mm outside diameter)
rr) IS-3989: Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
ss) IS-4111 (Part I to V): Code of practice for ancillary structure in sewerage system.

tt) IS-4733: Methods of sampling and testing sewage effluents.
uu) IS-4764: Tolerance limits for sewage effluents discharged into inland surface waters.
vv) IS-1068: Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
ww) IS-5382: Rubber sealing rings for gas mains, water mains and sewer
xx) IS-5822: Code of practice for laying of electrically welded steel pipes for water supply.
yy) IS-7740: Code of practice for construction and maintenance of road gullies.
zz) IS-8931: Copper alloy fancy single taps combination tap assembly and stop valves for water services.
aaa) IS-9762: Polyethylene floats for float valves.
bbb) IS-10592: Industrial emergency showers, eye and face fountains and combination units.
ccc) IS-12592: Specification for precast concrete manhole covers and frames.
ddd) IS-12701: Rotational moulded polyethylene water storage tanks.
eee) IS-13983: Stainless steel sinks for domestic purposes.
fff) SP-35: Hand book on water supply and drainage with special emphasis on plumbing.

2.11. Paving and Road works

a) IS-73: Paving bitumen
b) IS-702: Industrial Bitumen
c) IS-1201: Method of testing tar and bituminous materials. thru' 1220
d) : Practice followed by Indian Road Congress (all parts).

2.12. Earthquake Resistant Design

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

2.13. Chimney

a) IS-4998: Criteria for Design of R.C. Chimneys (all parts).
b) IS-6533: Code of practice for design and construction of steel chimneys
c) ACI-307: Specification for the design and construction of reinforced concrete chimneys
d) BS-4076: Specification for steel chimneys
e) CICIND: Model Code for concrete chimneys / Model code for steel chimneys

2.14. Cooling Tower

a) BS-4485: (Part 4) Structural design of cooling towers.

2.15. Structural Steelwork

a) IS-800: Code of practice for general construction in steel.
b) IS-802: Code of practice for use of structural steel in Overhead Transmission Line (All Parts).
c) IS-806: Code of practice for use of steel tubes in general building construction.
d) IS-808: Rolled steel beams, channels and angle sections.
e) IS-813: Scheme of symbols for welding.
f) IS-814: Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g) IS-816: Code of practice for use of metal arc welding for general construction in mild steel.

h) IS-817:	Code of practice for training and testing of metal arc welders.
i) IS-818:	Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j) IS-819:	Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k) IS-919:	Recommendations for limits and fits for engineering.
l) IS-1024:	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m) IS-1161:	Steel tubes for structural purposes.
n) IS-1182:	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o) IS-1200: (Part-VIII)	Method of measurement of steelwork and ironwork.
p) IS-1239:	Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q) IS-1363:	Black hexagonal bolts, nuts and locknuts (Dia. 6 to 39 mm) and black hexagon screws (Dia.6 to 24 mm). [all parts]
r) IS-1364:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (Dia. range 6 to 39 mm). [all parts]
s) IS-1365:	Slotted counter sunk head screws (Dia. range 1.6 to 20 mm).
t) IS-1367:	Technical supply conditions for threaded steel fasteners. (Part 1 to 18)
u) IS-1443:	Code of practice for laying and finishing of cement concrete flooring tiles.
v) IS-1608:	Method for tensile testing of steel products.
w) IS-1730:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
x) IS-1731:	Dimensions for steel flats for structural and general engineering purposes.
y) IS-1852:	Rolling and cutting tolerances for hot rolled steel products.
z) IS-1977:	Structural steel (Ordinary quality)
aa) IS-2016:	Plain Washers
bb) IS-2062:	Steel for General structural purposes.
cc) IS-2074:	Ready mixed paint, air drying, red oxide zinc-chrome, priming.
dd) IS-2633:	Methods of testing uniformity of coating of zinc coated articles.
ee) IS-3613:	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
ff) IS-3664:	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
gg) IS-3757:	High strength structural bolts.
hh) IS-4000:	High strength bolts in steel structures.
ii) IS-4759:	Hot dip zinc coatings on structural steel and other allied products.
jj) IS-5334:	Code of practice for Magnetic Particle Flaw detection of welds.
kk) IS-7215:	Tolerances for fabrication of steel structures.
ll) IS-7280:	Base-wire electrodes for sub-merged arc welding of structural steels.
mm) IS-7318: (Part-I)	Approval test for welders when welding procedure approval is not required.
nn) IS-8500:	Structural steel - micro alloyed (medium and high strength qualities).
oo) IS-9595:	Recommendation for metal arc welding of carbon and carbon manganese steels.
pp) AWS D.1.1	Structural Welding Code.
qq) IS-8640:	Recommendations for dimensional parameters for industrial building.
rr) IS-9178:	Criteria for design of steel bins for storage of bulk material (all parts).
ss) IS-12843:	Tolerances for erection of steel structures.
tt) IS-1181:	Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
uu) IS-2595:	Code of practice for Radiographic testing
vv) IS-2629:	Hot dip galvanising of iron and steel
ww) IS-3502:	Steel chequered plate.

xx) IS-3658: Code of practice for liquid penetrant flaw detection.
yy) IS-4353: Sub merged arc welding of mild steel and low alloy steel Recommendation.
zz) IS-5369: General requirements for plain washers and lock washer.
aaa) IS-6623: High strength structural nuts.
bbb) IS-6649: Hardened and tampered washers for high strength structural bolts & nuts.
ccc) IS-6911: Stainless steel plate, sheet and strip.
ddd) IS-7205: Safety code for erection of structural steel.
eee) IS-7307: Approved test for welding procedures
(Part I) Fusion welding of Steel
fff) IS-7310: Approval test for welders working to approval welding procedure.
(Part I) Fusion welding of Steel
ggg) SP-6: IS Handbook for structural engineers.

2.16. 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: Code of practice for painting of ferrous metal in buildings.
(Part I & II)
e) IS-2338: Code of practice for finishing of wood and wood based materials.
(Part I & II)
f) IS-2339: Specification for Aluminium Paints for general purposes in dual containers.
g) IS-2395: Code of practice for painting concrete, masonry and plaster surface.
h) IS-2932: Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.
i) IS-2933: Specification for enamel, exterior - a) undercoating, b) finishing.
j) IS-5410: Specification for cement paint.
k) IS-162: Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
l) IS-1650: Specification for colours for building and decorative materials.
m) IS-2395: Code of practice for painting concrete, masonry and plaster surfaces.
(Part I) Operations and Workmanship.
(Part II) Schedule.
n) IS-2524: Code of practice for painting of nonferrous metals in buildings.
(Part I) Pre-treatment.
(Part II) Painting.
o) IS-15489: Plastic emulsion paint.
p) IS-6278: Code of practice for white washing and Colour washing.
q) IS-10403: Glossary of term related to building finish.
r) IS-12027: Silicone based water repellent.
s) IS-13238: Epoxy based zinc phosphate primer (2 pack).
t) IS-13239: Epoxy surface (2 pack).
u) IS-13467: Chlorinated rubber for paints
v) IS-14209: Epoxy enamel, two component glossy.
w) BS-5493: Code of practice for protective coating of iron and steel structures against corrosion.

2.17. Sheeting

a) IS-277: Galvanised steel sheets (Plan & corrugated).
b) IS-513: Cold-rolled low carbon steel sheets & strips.
c) IS-730: Hook bolts for corrugated sheet roofing.
d) IS-801: Code of practice for use of cold formed light gauge steel structural members in general building construction.

e) IS-7178: Technical supply condition for tapping screw.
f) IS-8183: Bonded mineral wool.
g) IS-8869: Washers for corrugated sheet roofing.
h) IS-12093: Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanized steel sheets.
i) IS-12436: Preformed rigid Polyurethane (PUR) and Polyisocyanurate (PIR) foams for thermal insulation.
j) IS-12866: Plastic translucent sheets made from thermosetting polyester resin (glass fiber reinforced).
k) IS-14246: Continuously pre-painted galvanized steel sheets and coils.
l) BS-5950: (Part VI) Code of practice for design of light gauge profiled steel sheeting

2.18. Plastering

a) IS-1661: Code of practice for application of cement and cement lime plaster finishes.
b) IS-2402: Code of practice for external rendered finishes.
c) IS-2547: Gypsum building plaster.

2.19. Acid / Alkali Resistant Tiling

a) IS-158: Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
b) IS-412: Expanded metal steel sheets for general purpose.
c) IS-4443: Code of practice for use of resin type chemical resistant mortars.
d) IS-4456: (Part I & II) Method of Test for chemical resistant tiles.
e) IS-4457: Ceramic unglazed vitreous acid resisting tiles.
f) IS-4832: Specification for chemical resistant mortars.
(Part I) Silicon Type
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(Part III) Sulphur Type
g) IS-9510: Bitumastic acid resisting grade.

2.20. Safety

a) IS-1641: Code of practice for fire safety of buildings - General principles of fire grading and classification.
b) IS-1642: Code of practice for fire safety of buildings - Details of construction.
c) IS-3696: (Part I & II) Safety code for scaffolds and ladders.
d) IS-4081: Safety code for blasting and related drilling operations.
e) IS-4130: Demolition of buildings - code of safety.
f) IS-5121: Safety code for piling and other deep foundations.
g) IS-5916: Safety code for construction involving use of hot bituminous materials.
h) IS-7205: Safety code for erection of structural steel work.
i) IS-7969: Safety code for handling and storage of building materials.

2.21. Architectural Design of Buildings

a) SP-7: National Building Code of India.
b) SP-41: Hand book on functional requirements of buildings (other than industrial buildings).
c) ECBC: Energy Conservation Building Code
d) GRIHA: Green Rating for Integrated Habitat Assessment.

2.22. Other

a) Indian Road Congress (IRC) Bridge Codes
b) Indian Railway Standard Bridge Rules

3. GENERAL

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

4. LAYOUT

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. **If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks.** If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench
mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the opinion of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderer’s shall take into account the cost of these in quoting their price.

5. WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or

licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6. TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

7. INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

8. SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all important items of work.

9. CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, porcelains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All handling of materials shall be with cranes.

Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed.

Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

PART-II

SPECFIC TECHNICAL REQUIREMNT

NTPC Limited

(A Government of India Enterprise)

PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 6)

SECTION - VI

BIDDING DOCUMENT NO.: CS:9585-001-2

NTPC Limited

(A Government of India Enterprise)

PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)

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b) CONSTRUCTION METHODOLOGY

c) BORE HOLE DATA

d) WIND DESIGN CRITERIA

e) SEISMIC DESIGN CRITERIA

f) QA REQUIREMENT

g) RAINFALL DATA(Hydrological Data)

h) HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM (for concrete surfaces of IDCT)

(i) LIST OF TENDER DRAWINGS

(j) ELECTRICAL RESISTIVITY DATA

(k) SITE MANAGEMENT PRACTICE DURING CONSTRUCTION PHASE

1.00.00 **GENERAL**

1.01.00 This specification is to cover, survey works , site leveling works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour& materials and construction of all civil, structural and architectural works by the Bidder.

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein.

The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.

All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder.

The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works.

Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and theborelog data is furnished in Annexure 'C'. Detailed Geotechnical Investigation shall be carried out by the bidder. The foundation system shall be evaluated by the bidder based on the above mentioned detailed geotechnical investigation.

The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder's work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer.

The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. deptt. As per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.

The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.

Bidder or his agencies engaged as detailer for fabrication drawings should have the experience of detailing for power house structures or steel plant or Industrial structures like Petro/Chemical/Refinery/Cement Etc.

Bidder shall obtain the approval of detailing agency for making fabrication drawings before engaging them.

2.00.00 SCOPE OF WORK

2.01.01 The scope of work for the EPC contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.

2.02 Construction Facilities

For details of construction facilities refer to Part-A of this specification.

2.03 Exclusions:

The details of exclusions and terminal points, refer to Part-A of this specification.

3.00.00 SUBMISSIONS

3.00.01 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

Project design intent document giving the basis of design, which shall cover all the aspects, parameters, assumptions, references, structural idealization / mathematical model, loading cases, load combinations, basis of analysis and design of all buildings, facilities, systems and structures etc. shall be furnished and got approved before commencement of detailed engineering.

a) Structural analysis, design calculations and drawings of substructure and super structures for all buildings, structures, facilities, and systems. Analysis, design calculations and drawings for all services like roads, culverts, bridges, road/rail crossings, drainage pump houses (if required), drains, sewers, sewage pump house, water supply, water tank, coal conveyor galleries, trestles, transfer points, trenches, ducts, etc.

b) Survey drawings indicating spot levels for the area under the scope of work and L-section along pipe corridors outside plant boundary.

c) Plant'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings and facilities, piping/cable corridors, railway lines, green belt, etc.

d) Drawings showing underground facilities with co-ordinates and invert levels of the facilities like buried pipes, buried cables, trenches, ducts, sewers, drains, sumps, pits, culverts, manholes, etc.

e) **Bidder shall engage a specialized architect consultants with experience in different design aspects like architecture, interior design & landscape design. The consultant shall be involved in the overall Architectural design and Character of the buildings. However detailing work of the individual buildings may be done by In-house architects having adequate experience**. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect

h) All architectural drawings required for execution of construction work such as detail floor plans, detail elevations, detail sections and other miscellaneous architectural details such as finish schedule(internal & external), colour schemes (both internal and external), doors and windows, flooring details &pattern,Atrium Vault/ Dome in polycarbonate sheet in the roof, false flooring, false ceiling, etc., architectural facia and

projections, miscellaneous stair details &architectural details like, coping, flashing, khurras, water proofing, fillet, roof decking, wall cladding, surface drains, rain water down comers, sanitary, plumbing, etc.

i) Design criteria and design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundation for TG, BFP, Mills, Fans (PA, FD, ID& Seal Air), Crusher etc.

j) Write-up on various statutory requirements and their compliance for various buildings, facilities, structures and systems, etc.

k) As Built final Architectural drgs andAs Built- Final Shop drawings/fabrication drawings of all structural steel works(only for reference) on CDs and design calculations for important joints/connections

l) Construction and erection procedure for all major structures such as Main Plant building including Control tower, Mill and Bunker building including coal bunkers, Transfer Points, Conveyor Galleries, Boiler/ ESP structures, Chimney,Auxiliary Cooling Towers, Switchyard Structures, ~~Ash Slurry PH, Ash Water PH~~, TG foundation and other machine foundations, Clarifiers, etc. covered under the Bidder's scope.

m) In case of piling, scheme for initial pile load tests in vertical, lateral and uplift modes along with supporting design calculations, scheme of routine load test of piles, High Strain Dynamic Load Test, Pile Integrity Tests and methodology for installation of working piles.

n) In case of piling, the design of piles in terms of type, rated capacity, length, diameter and termination criteria to locate the founding level.

o) Marking scheme identifying the equipment lay-down areas, with distinctive colour scheme.

p) Material test certificates.

q) Design criteria (for approval) and drawings(for information only) for Boiler/ESP supporting structures.

r) As built drawings with quantities of various items of work system wise, building wise, structure wise, etc. duly certified by Site after execution of work for information/record.

s) Details of corrosion protection measures for all structures.

t) One complete set of applicable standards, references, specifications, code of practice along with soft copy (wherever required with minimum 2 years license fee) to the Engineer for use at site.

u) Wherever applicable, scheme for dewatering, shoring, strutting/sheet piling.

v) All other design details/drawings or any other submission as indicated elsewhere in this specification and as required by the Employer.

Commencement of fabrication and erection and construction shall be done after approval of the relevant documents and drawings. All drawings shall be of standard sizes (Metric System) and shall be made on AutoCAD. All documents shall be made using MS office. Bidder shall submit all documents and drawings as per the followings:

Drawings:	-	Soft copy via C-folder for all drawings.
	-	After approval of drawings 6 Hard copies of each construction drawing shall be submitted to Owners site office
As Built Drawings:	-	In CD (Compact disc).
Design/Document:	-	Soft copy via e-mail/ C-folder and two set of hardcopies.

In general 3D modeling and structural frame analysis and design for the plant structures shall be submitted by the bidder for Employer's review and approval. Soft copy of 3D modeling (including input and output files shall be submitted

All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter wise) and structural steel (section wise).

4.00.00 GENERAL LAYOUT PLAN

4.01.00 The preliminary layout plan proposed for the project is shown in the drawing no. 9585-999-POC-F-001 titled "General layout plan". It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

Bidder shall prepare the detailed layout of the plant facilities which are in his scope and shall submit the same for Owner's approval.

While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects.

a) All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

b) Face of the buildings and facilities are located in such a way so as to have an offset of minimum 20m with respect to centre line of double lane road and 15metre with respect to centre line of single lane road.

c) The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.

d) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working parallely with the Bidder within the plant premises.

e) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores have been earmarked on the General Layout Plan.

f) No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks, Hydrogen plant complex, etc., except those permitted by Owner.

g) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed. However the same may be adopted subject to approval of the Employer.

h) All the buildings and facilities shall be approachable by fire tenders.

4.02.00 Technical Specifications for Watch Tower

Watch Towers shall be RCC construction with all-weather enclosure at 6M height. Watch Towers shall be provided at 600 m interval along the Boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with caged MS ladders.

4.02.01 Construction Stores

2 Nos. of Construction Stores with 1050 Sq.M. floor area of each store shall be constructed. The stores are pre-engineered buildings and design shall be as per the latest industrial practices. These stores shall be used by the contractor for the storage of material in construction phase, and after completion of work shall be handed over to owner in good condition for use by the owner in O &M stage.

4.02.02 **Steel Storage Yard**

Steel Storage Yard of 10,000 SQ.M. shall be provided with heavy duty paving as per details given in Clause No. 5.26.00. Fencing around the Steel storage yard shall also be provided as per details given in Clause No. 5.07.15.

4.03.00 **Site Levelling And Slope Protection Work**

4.03.01 Complete levelling of entire plant area and township area including the area earmarked for administration building, ash based units, ash silos, railyard and associated facilities shall be done by the Bidder.

Bidder shall carry out the topographical survey before he commences detailed design and site leveling. This survey shall cover the entire plant area and township area including the areas earmarked for administration building, ash based units, ash silos, railyard, raw water pumphouse& associated facilities, reservoir and the diversion drains in Bidder's scope of work. Based on field observations the contractor shall prepare and submit for Owners review the survey maps of the surveyed sited on suitable scale, indicating grid lines, contour lines and demarcating all permanent features like roads, railways, water-ways, buildings, power lines, natural streams, trees etc. For each area two sets of survey maps shall be prepared and submitted, one showing the spot levels and contours with grid lines and the other showing the grid lines, contours and permanent features.

Established methods of surveying like triangulation, traversing, fly leveling etc. shall be adopted for the survey work. Spot levels shall be taken at 25 metres interval and at closer intervals where pits, undulations etc. are met with. These levels shall be taken in two orthogonal directions. Contours shall be plotted at 0.5m interval.

It is proposed that for the purposes of site leveling the entire plant and associated areas will be divided into various blocks as defined in the drawing no. 9585-001-POC-A-001 titled, "Site Levelling Works ". Each block shall be finished to the formation level as specified in drawing. Bidder shall deploy adequate number of experienced site leveling contracting agency(s) with requisite earth moving and compacting equipment to complete the work as per schedule.

Since the construction of roads and drains for the entire plant is included in the scope of Bidder, it shall be the responsibility of the Bidder to ensure that these facilities are also constructed along with site leveling works. Bidder shall ensure that road access and drainage facilities for each block is available when site leveling in that block is completed. Unless otherwise instructed by the Engineers, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block.

The specified formation level(s) shall be achieved either by excavation where the existing ground levels are higher than the specified formation level or by raising by controlled filling with borrowed earth where the existing ground levels are lower than the specified level.

The excavation shall be in all types of soils or rock or a mixture of these. Bidder should assess and satisfy himself about the actual nature of soil present at site, before submitting his bid.

In some areas excavation of ash is also involved. The excavated Ash shall be used for filling for site levelling works. Areas for Ash filling shall be identified in consultation with owner and area shall be finalised after written permission of the Engineer. Earth cover needs to be ensured over ash filling.

	All materials arising out of site clearance and excavation shall be the property of owner. They shall be dealt with in the manner specified by the Engineer. Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material. Other materials like twigs, leaves, roots, vegetable and organic matters etc. shall be termed as unserviceable material and shall be sorted out from the serviceable materials before disposal. They shall be cleared from the area and disposed off at places within Owner's acquired land for the plant including the ash disposal area in a manner as directed by the engineer. If the excavated material is suitable and accepted by the Engineer as fill material, the same can be used for filling in other areas where raising by filling is required. Otherwise the same shall be taken and stacked at places(s) within the plant boundary as directed by the Engineer. Filling with rock shall be done only after the written permission of the Engineer in the following manner: - Filling with rock shall be done only in areas identified for laydown and preassembly and ash based units. - Maximum size of rock used for filling should not be more than 150mm in all direction. - Original ground after removal of all organic and vegetable matters shall be consolidated by rolling as directed by the engineer subject to a minimum of six passes of 8-10 tonnes roller. - Excavated rock shall be laid (on original ground or after filling 300 mm thick layers of soil as specified), in layers not exceeding 1000 mm and rolled with with vibratory roller (10-15 tonnes static weight) with minimum six passes. - Over the compacted layer of rock, soil shall be filled in horizontal layers not exceeding 300mm in compacted thickness. The soil shall be compacted as specified elsewhere. - It shall be ensured that the top soil layer is in minimum 3 layers of 300 mm each. To achieve this the thickness and number of rockfill layers below can be suitably adjusted. Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. "9585-001-POC-A-001. However, Owner does not lake any responsibility about the accuracy of the survey details furnished and any variation of the said data shall not constitute a valid reason for changing the terms and conditions of the contract. Bidder is requested to carry out his independent assessment of the existing ground levels before furnishing his. bid Detailed survey shall be carried out by Bidder after award of work and all findings as stated earlier shall be submitted for Owner's review.
4.03.02	All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding within the limits of overall land acquisition line and in adjoining areas.

4.03.03	Before commencement of cutting/filling, all organic and vegetable matters like grass. Plants shrubs bushes, weeds, trees (with girth less than 30 cm measured at height of 1m above ground level) etc. in the areas to be filled, shall be completely removed along with their roots and disposed off. It shall also be ensured that the area to be filled is clear of any water, slush etc. Original ground shall be compacted by rolling as directed by the Engineer subject to a minimum of six passes of 8 to 10 tonne roller The earth shall then be spread in horizontal layers not exceeding 300 mm in compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may by required to obtain a compaction of 95% or more of Standard Proctor's maximum dry density. The moisture content of the fill material shall be controlled to obtain near optimum moisture content during compaction. The fill material shall be tested for determining optimum moisture content and maximum dry density by Standard Proctor Test as per IS : 2720 (Part-VII). The fill material shall also be tested for determining moisture content before compaction as per IS:2720 (Part-II) For each of the above tests, one sample for every 10,000 cubic metre of fill material shall be tested. Additional samples shall be tested, whenever there is a change in the source or type of fill material. The compacted soil shall be tested for its dry density as per IS2720 (Part-XXIX) or Part-XXVIII). Samples shall be taken at the rate of one sample for every 10,000 sq.m. area for each compacted layer. In addition random checks shall be carried out in compacted soils by means of Proctor needle penetration. Bidder shall submit to the Engineer, the test results immediately after completion of the tests. A sample shall be deemed to have passed the test when the in-situ dry density is equal to or more than the specified percentage of maximum dry density. If a sample taken from a layer fails to pass the test, the layer shall be further compacted till two samples taken and tested from this layer pass without any negative deviation. Only after this. spreading of further layers shall be taken up.
4.03.04	Before start of filling, the Bidder shall submit to the Owner his proposal for the methodology to be adopted for compaction for each type of fill material. The Bidder shall also carry out compaction trials to establish the proposed methodology. The Bidder shall start the compaction work only after approval of the methodology by the Owner
4.03.05	The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally.
4.03.06	The borrow areas outside the overall plant boundary limits for obtaining suitable fill material which is required over and above the earth available after cutting high grounds within the plant area, for site levelling shall be arranged by the Bidder himself and all expenses in respect of royalties, taxes, duties, etc. for borrow areas/fill material shall be borne by him. He shall also obtain and submit to the Owner the necessary clearances/permission from the concerned authorities for the borrow areas/fill material.
4.03.07	Material suitable for filling shall be loaded and transported to the filling site by the Bidder. Any coarse grained or fine grained low plastic soil, free from shingle, salts, organic matter, sod or any other foreign substances, may be used for filling. The Bidder shall test the fill material to establish its suitability and submit its results to the Owner. Fill material shall be approved by the Owner. The following types of materials shall not be used for filling:

a) Material from swamps, marshes and bogs.

b) Expansive clays

c) Peat, logs, stumps, sod and perishable materials.

d) Materials susceptible to combustion

e) Any material or industrial and domestic produce which will adversely affect other materials in the work.

f) Materials from prohibited areas

4.03.08 Bidder shall include in his offer any extra filling that may be required on account of subsidence of the original ground due to overburden of filling above and/or compaction works for site levelling.

4.03.09 After levelling, the contractor shall establish concrete pillars at the intersection points of the grid lines for future reference. These pillars shall project at least 450 mm above the formation level and shall be labelled permanently with their respective coordinates and reduced levels.

4.03.10 Fillingupto the specified formation level shall extend at least 2.0m beyond the outside face of boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical:2 Horizontal) and provided with good quality dry stone pitching minimum 300mm thick for slope upto level difference of 3m. If the level difference is more than 3m, the stone pitching shall be provided with RCC bands of size 300mmx300mm at minimum spacing of 3m horizontal and 6m vertical spacing and with suitable benching.

4.03.11 For site levelling of railway siding area (as marked in site levelling drawing) shall also comply to railway standards and RDSO guidelines in addition to the above clauses.

5.00.00 SALIENT FEATURES & DESIGN CONCEPT

This section of specification covers salient features and design concepts of Architectural, Civil & Structural works pertaining toMain Plant Buildings, Chimney, Cooling Towers, ACW System & Make-Up Water System, Water &Effluent Treatment Plant And CPU Civil Works, FDPS System, Balance of Plant Buildings, Coal Handling & Ash Handling Systems, Switchyard Structures,Facilities For Railway Siding, Fuel Oil Handling System, Office Buildings, Roads and Drainage , FGD system.

5.00.01 Architectural concepts & design

a) Bidder shall engage a specialized architect consultants with experience in different design aspects like architecture, interior design & landscape design. The consultant shall be involved in the overall Architectural design and Character of the buildings & shall be available for discussion & meetings whenever required by the owner. However detailing work of the individual buildings may be done by In-house architects having adequate experience. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect. Perspective / Panoramic Views of Main Power House, Admin, Service, Canteen, Auditorium, Gate Complex, IT building & Time Office shall be submitted in Hard Copy in Laminated A-1 Size (Two Numbers). A Panoramic Bird's Eye View of Overall plant shall be submitted in laminated A-1 Size hardcopy (Two Numbers) A.ll drawing and document shall be duly stamped by the Registered Architect.

Drawings, Detail Drawings, Perspective View &Panormic Bird's Eye View. Perspective / Panoramic Views of Main Power House, Admin, Service, Canteen, Auditorium, Gate Complex & Time Office shall be submitted in Hard Copy in Laminated A-1 Size (Two Numbers). A Panoramic Bird's Eye View of Overall plant shall be submitted in laminated A-1 Size hardcopy (Two Numbers) A.ll drawing and document shall be duly stamped by the Registered Architect.

b) Power Plant Buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehendible scale, blending colour scheme with the surroundings.

c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction.

d) Overall colour scheme of the Main plant building and other buildings shall be designed judiciously and in a comprehensive manner taking into a account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements.

e) For adequate light and ventilation, National Building Code recommendations shall be followed. All buildings having height more than 4.0 m shall have glazed ventilators.

f) Architectural design of Main Power House Building, Administration Building, Service Building, Workshop, O&M Store, ESP control Building & Switchyard control building shall be suitable for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose.

g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations &incorporating sustainable building design features like energy efficiency, Solid waste management, water conservation and recycling, use of local material etc.

IT

h) During design stage, Technical specification as prepared shall govern the finishes.Service building, Administration building, Canteen building, &Auditoriumshall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building with a minimum Three (3) star rating. Bidder shall perform all services related toGRIHA certification including preliminary assessment, GRIHA facilitation, simulation& analysis leading to obtaining the final certification by GRIHA. For information aboutGRIHA, bidder is requested to visit the web site www.grihaindia.org. Bidder shall obtain and submit final certificate from GRIHA to the Owner.

Bidder shall perform all services related to GRIHA certification including payment of registration fees for above buildings with GRIHA, procurement, supply and installation of energy source as per GRIHA requirement, GRIHA documentation, energy simulation and daylight analysis for obtaining the final certification by GRIHA.

i) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.

j) All the buildings and site development including landscaping shall be designed to take care of Rain water harvesting & Ground water recharging. Development of rain water harvesting scheme for the project and obtaining approval of the scheme from Central Ground Water Board is in Bidder's Scope.

k) For Control Rooms of MPH/ ESP Control Buildings, Dry Wall Construction Technology shall be incorporated.

l) Overall emphasis shall be on developing eco-friendly architecture, merging with the nature with its own sustainable energy management systems. Ecofriendly architecture means design and constructions that are eco-friendly and helps to save the natural resources of the earth. . The above definition is only indicative and the bidder shall incorporate the above features into design and construction to achieve a sustainable, eco friendly architectural design for the whole project.

m) Landscape Development

There shall be comprehensive landscape development in entire Plant area to create a pleasant and healthy environment. The scope of work for landscape and horticulture work shall include supply and planting of trees, shrubs, hedges/edges/borders, grass lawn around different areas, buffer and peripheral plantation etc. The scope shall also include supply and installation of all landscape furniture i.e. Park-Benches, & Gazebos, Landscape fountain & water bodies, Landscape Pavers/ Tiles etc& all associated electrical works/ items, Mechanical works/items and civil works and all other work required for completion of Landscape development. The landscape design and drawing shall be developed by competent and signed byLandscape Architect. The landscape shall use the suitable plants and trees preferably local trees, plants, and shrubs. There shall be provision of pathways in and around the landscaped area. Around the pathways and roads, trees shall be planted. There shall be provision of drip/sprinkler irrigation system for irrigation of landscaped area. There shall be intense landscape with four water body development one each near Main gate complex, Administration building, Service building and Canteen building. Minimum size of water bodies shall be as given below:

Drip/sprinkler/pop up irrigation system shall be provided and installed by the bidder for irrigation of entire landscape area and all plantations.

Administration Building and Service Building – 5.5m diameter and 1.0m depth
Canteen Building and Gate Complex – 3.0m diameter and 1.0m depth

The landscape (including water body) around Administration Building, Service Building, Auditorium Building, and Canteen building shall meet the GRIHA requirement for 3 STAR rating.

n) The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for peripheral green belt of average width of 100m around the main facilities of power plant. In addition to that laydown areas and other vacant land of the plant will be used by owner for the development of green belt.

5.01.00 **Main plant Buildings/ Structures shall comprise of:**

All floors indicted in subsequent pages shall be total area of building

a) Main Power House

b) Mill Bunker Building

c) Transfer Points , Conveyor Galleries & Trestles

d) Machine Foundations in Main Plant

e) Boiler Structure

f) Compressor House

g) ESP Structure

h) ESP Control Building

i) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level.

j) Pipe & Cable Gallery

k) Service Building

The Main Power house, Bunker building, transfer points, conveyor galleries and trestles, boiler supporting structure, ESP supporting structures including inlet and exhaust duct support structures, Pipe cable Galleries & trestles shall have structural steel framed super structure.

All other buildings may have either RCC or structural steel framework.

Brief description of the above mentioned Main Plant Building is furnished herein:-

a) Main Power House

(i) Salient Features:

shall be of structural steel framed structure and

Main Power House shall consist of the Turbine bay, adjacent Deaerator Bay, electrical bay & Common Control room Building (CCR Building) (as stipulated elsewhere in this specification). The Turbo – Generator (TG) foundation, MDBFP & TDBFP foundations andshall be located inside the power house and their foundation system shall be as per design concept of machine foundation. All other equipment foundations (including Heaters & Deaerators) shall be supported on RCC floors with structural steel beams. The RCC floors shall comprise RCC slab over profiled metal deck sheets (to be used as permanent shuttering but not to be considered for design of RCC slab as composite slab). Shear anchor studs shall be provided through metal deck at regular interval on all top flange / flange plate of structural beams. However, steel gratings, chequered plate flooring as well as precast RCC covers shall be provided as per the functional requirements. All RCC pits & trenches below ground floor slab (including CEP pit) shall be covered with minimum 40 mm thick MS grating supported on structural steel beams. The RCC pits shall also be provided with a sump at the corner for dewatering with submersible pumps. Staircases & ladders shall be provided for access to these pits. EOT cranes shall be placed in the Turbine Bay with the Gantry Girders(supporting Crane Wheel Loads) supported on structural steel brackets on A & B row columns). Walkway with chequered plate shall be provided at crane girder level at both 'A' row & 'B' row side with caged ladder access from the operating floor.but

All columns ~~& beams~~ of Main Power House shall be of structural steel ~~girder (open web or solid web)~~ with base plate level of columns 1.20m below ground floor slab level in general except for other pit areas where structural steel column shall be extended below upto a depth lower than the pit top surface such that the column base plate & stiffeners are concealed below the pit raft level. ■

■ Auxiliary columns for supporting floors in AB bay in main Power House shall be either of structural steel of concrete (Pre-cast) construction. Design, fabrication/ manufacturing of precast structural members like column & beams , handling / erection and jointing there of shall be done as per IS 15916.

The roof system in Turbine bay shall comprise a structural steel girder (open web or solid web) for the entire bay width. The roof slab shall consist of 40mm thick (min.) RCC slab supported on profiled metal deck sheet. The metal deck sheet shall be supported on structural steel purlins. The purlins shall be in turn be supported on turbine bay roof girder top chord at regular interval. Additional waterproofing shall be provided above the roof RCC slab as per details mentioned elsewhere in this specification. 1 in 100 slope shall be provided for the turbine bay roof sloping downwards towards the A-row (towards transformer yard) .

Minimum 150mm dia galvanized mild steel pipes shall be used at A-row & C-row as Rainwater Down comers. Staircases in main power house shall be of structural steel. Treads & risers of each staircase shall be 40mmthick MS grating and handrail/ hand post shall be 32mmNB circular hollow sections unless specified otherwise in architectural section of the specification. All staircases in Turbine Bay and Deaerator Bay shall be enclosed with 230thk brick masonry Wall with fireproof doors at all floor landing levels. The parapet wall shall be of minimum 1m height and shall be provided all the around roof of main plant building.

All edges of openings shall have edge protection angles (minimum ISA 75x75x6) and handrails with hand posts (Hand post spacing 1.50m maximum)(Hand post spacing 1.00m maximum).

ii. Design Concept:

Main Power House shall be designed as moment resisting sway frame in the transverse direction and braced in the longitudinal direction. However, due to functional requirement, vertical bracings to the column in CCR Buildingnot to be provided at (& above) the operating floor level and CCR Building frames shall be designed as moment resisting frames in both transverse and longitudinal directions.

All beam column moment connections shall be designed for adequate ductility. The building shall have connectivity with walkways from Boiler & Service Building through sliding bearing only. The connectivity with cable gallery shall be as specified in Pipe &cable gallery section of this chapter. Floor level acceleration spectra shall be generated during seismic analysis for design of pipe supports / equipments located at the elevated floors. Adequate number of thermal expansion gap (minimum 2.00m) between adjacent structural frames at expansion joint and minimum 50mm between RCC slabs at expansion joint) shall be provided between the units and Common Control Building.

In the RCC floor/ roof slabs, the spacing of shear anchor studs on structural beams shall be minimum of the spacing required for i) the restrainment of compression flanges of beams and ii) transfer of the horizontal shear at floor/roof to the supporting beams.

The roof girder in Turbine Bay shall be provided with a camber to take care of deflection due to dead weight.

The Main columns in A, B &C rows of Main Power House Building shall be built-up I sections. Rolled sections/ I sections with additional flange plates shall not be acceptable for main columns & auxiliary columns. The roof truss to column connection shall be bolted connection using high strength bolts (grade 8.8/ IS 1367). The roof truss of Turbine Hall shall be adequately braced in plan using Tie level and rafter level bracings. The longitudinal bracing shall comprise a pair of Box sectionconnected to the column flanges and detailing shall be adequate to restrain the entire column cross- section. Minimum gusset plate thickness for bracings shall be 12mm.

The base plates of Main Columns in A, B, & C rows shall be grillage type of minimum depth 800mm and comprising bottom base plate, top cap plate & interconnecting vertical stiffeners.

The CCR Building structure shall have large span roof girders for the roof structure of main Control room such that no internal column within the control room floor exist. Which interfere with equipment layout

For all other design methodology, refer to Design Criteria specified elsewhere in this specification.

Architectural Features

This building shall be of Structural Steel Framed structure and shall be completely covered with external cladding and RCC roof.The external vertical face(herein stated as 'A' row) of Main Power House facing (& adjacent to) the transformer yard and also the two gable ends shall be completely covered with vertical cladding comprising 3.0m high brick wall (on Ground floor slab) and single skin profiled vertical metal sheet for the remaining height

except for the vertical segment between operating floor & Gantry girder bracket level where double skin vertical metal sheet shall be provided. In front of the Power Transformers, RCC fire barrier wall shall be provided as per functional requirement in lieu of brick wall at A-row.The above mentioned RCC wall shall be attached with single skin metal sheet on external face. The 'A' row & Gable End columns projecting inside the turbine hall shall be concealed with single skin profiled metal deck sheet from operating floor level to crane girder bracket top level

The external vertical face (herein stated as 'C' row) facing (& adjacent to) the Boiler area shall be completely covered upto the Deaerator floor level with vertical cladding comprising 3.0m high brick wall on Ground floor followed by either single skin metal sheeting with runners or brick wall sand witched with single skin metal sheeting on external face(for all floors requiring 4 hrs of fire rating eg Cable Spreader room, Ventillation/ Air Washer Room & AHU Rooms)

The internal vertical interface plane between Turbine bay & Deaerator bay (herein stated as 'B' row shall have brick masonry Wall from RCC roof slab level of turbine bay (AB bay) upto specified floor level below such that Turbine bay & Part of Daerator bay below the Deaerator supporting floor level is completely covered on all sides.

Glazing for A Row, C Row& Gable end shall be Reflective6mm thk clear toughened glass with Aluminium frame. Hermetically sealed double glazing shall be provided between A/C areas & non-A/C areas. Light Weight Aerated Concrete Panel with Single Skin Metal Panel cladding shall be provided in exterior of UPS Battery room area and Control Equipment Room area. All internal side of Aerated concrete panel and columns in air-conditioned areas in MPH shall be encased with Aluminium Composite panel cladding

Inside the main power house building, brick masonry wall (and fire proof doors) shall be provided for switchgear rooms, cable spreader rooms, MCC rooms, AHU rooms, Air Washer room & Oil rooms and all other rooms where fire protection is envisaged.

Cut-outs and opening shall be provided in floors and walls as per functional requirement.

All door, windows in air conditioned area and all windows glazing shall be provided with Aluminium frame work Steel door and Fire Proof doors shall be provided as per requirements.

Stairs in BC Bay and on A-Row shall be provided as per functional requirement and as per National Building Code and factories Act.

All stairsin BC Bay lift lobby Area shall bein RCC. Stainless steel railing shall be provided at TG Floor level for all cut-outs/ openings, walkway at ~~24.0m~~, cut-outs at lower level that are visible from TG Floor level and stairs near lift lobby.M.S. railing shall be provided for all other locations. ~~Flooring interface with Floor cut-outs and R.C.C Slab at operating Floor level shall be finished with 3mm thick Stainless Steel plate of grade SS 316~~.

All peripheral edges of floor cutouts / openings at TG Floor level and covered with grating / chequered plates, Expansion joints along TG deck, structural expansion joints shall be covered with 2 mm thick stainless steel plate of Grade SS316

For each unit minimum one no. Gent's toilet with adequate facilities including Drinking water space and Janitor's space shall be provided at each level of Power house Building, in addition one no Ladies toilet shall be provided in each unit at 0.00M and Mezzanine floor level and CCR Level. A separate ladies and Gent's toilet and pantry shall be provided for CCR approachable from CCR / CER.

separating Air -conditioned and non-Air-conditioned areas shall be of 24mm thick Hermetically sealed double glass consisting of Fire resistant glass of min 11mm thick clear, toughened, inter layered 120 minute fire rated for both integrity and radiation control and 6mm thick tinted glass with 7mm gap and with suitable fire rated frame of 1.3mm thick galvanized steel sheet.

The partition shall be up to false ceiling level and wall above up to 24.0M/25M shall be finished with Aluminum Composite panels cladding.

B Row portion in TG Hall ~~fronting Control Room&CERand glazed partitions in CER/ CCRshall be of Fire resistant of min 11mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control partitions up to false ceiling level and wall above up to 24.0 M, finished with Aluminuim Composite panels cladding~~.

Control room/ Control Equipment Room, False Ceiling shall have Cat Walk Way above for service/ maintenance.

Main power house building shall be provided with passenger lift in BC way as specified in

subsection A-05 of PART-B of technical specification.

Adequate partitioning as per functional requirement above false ceiling in control Room& CER shall be provided for Inert Gas zoning.

Internal steel columns in Air Conditioned Area of Main Power House Building shall be encased with Aluminium Composite Panelling up to false ceiling.

Functionally the very heart of Power House Building is its Control Room. Special attention shall be given for conceptualisation of interior design of the Control Room.

Metal Panel Cladding shall be composed of Different Colour shades to match with the surroundings. External finish of Masonry wall shall be premium acrylic smooth exterior paint with silicon additives finish.

Mill and Bunker building

Salient Features

The mill bunker building shall house coal mills, feeders, Cylindrical Coal Bunker & Conical Hopper, Tripper Conveyor & its drive and monorails. All columns, main beams and secondary beams shall be made of structural steel. The RCC floor slabs (supporting the Feeder and Tripper Conveyors) shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering) not to be considered for design of RCC slab as composite slab) and shear anchor studs welded to the top flange plate of secondary & main structural steel beams, (which supports the RCC slab & metal deck sheet).

Bidder shall integrate the Mill & Bunker Building with boiler supporting structure.

Access platforms shall be provided at minimum one (1) level above bunker supporting level for inspection and testing of bunker and hopper connections. Minimum (1) Nos. of man hole/ access window shall be provided for maintenance of silo.

The bottom level of base plates of columns shall be 1.20 m below the finished floor level of ground floor of Main Power House. The columns of Mill-Bunker building shall consist of built up structural steel I-sections. Rolled sections with additional cover plates on column flange shall not be acceptable for column sections.

The cylindrical coal bunker and conical hopper shall be made of structural steel. The inside surface of hopper shall be lined with stainless steel plates the details of which are mentioned hereafter in this specification.

Structural steel brackets with PTFE bearings shall be provided at the end columns to support the external gallery of the Tripper Conveyor

The Mill-Bunker building roof shall be provided withPre-fabricated insulated metal sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00, Part-B (Civil) of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

The RCC floor supporting the Tripper Conveyor shall be fully covered upto the Roof level with single skin metal sheet (& structural steel runners).

Design Concept

The Mill Bunker Building shall be conceptualized as moment resisting frames in transverse direction and longitudinal direction. In the transverse direction the bracings may be provided, wherever feasible, in order to meet the deflection requirement specified elsewhere in this section. Bracing member shall be connected to column flange plate through gusset plate (minimum 12mm thick).

Minimum wall thickness of structural steel Bunker plates (cylindrical shell) shall be 12mm inclusive of 5 mm corrosion allowance. Minimum wall thickness of Hopper shall be 12mm.

~~Minimum thickness of structural steel Bunker plates shall be 12mm inclusive of 4mm corrosion allowance~~. Minimum wall thickness of Hopper shall be 8mm. Minimum thickness of stainless steel liners on the entire inner surface of hopper wall shall be 4mm conforming to ASTM A240 S304 (Type 304) with Mill finish 2B cold rolled, annealed, descaled (pickled) and

skin passed . To ensure smooth flow of coal, the hopper surface shall be provided with minimum angle of 73^{o} with the horizontal plane.

The top of the cylindrical bunker shall bear no load/ reaction from the tripper floor and accordingly neoprene bellow strap shall be provided at the interface between the two structures to allow free deflection of the tripper floor. Neoprene bellow strap shall be provided all-round the bunker to effectively seal the gap between top of bunker and sealing plate below bunker.

For all other design methodology, refer to Design Criteria specified hereafter in this specification.

A. Architectural Features

The Mill & Bunker Building shall be a structural steel framed structure having RCC floors and prefabricated insulated metal sandwiched panel sloped roof. The tripper floor side cladding shall be Single skin Metal cladding with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. Rainwater down comer shall be of galvanized MS pipes and shall be located at every column location.

b) Transfer Points and Conveyor Galleries in Main Plant Area

Transfer Points

The transfer points shall be framed structure of structural steel work having RCC floors (supported on structural steel beams) and prefabricated insulated metal sandwiched sheet sloped roof. The RCC floor slabs shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering not to be considered for deign of RCC slab as composite slab) and Shear anchor studs shall be provided with stud welding through metal deck at regular interval on all top flange / flange plate of structural beams which support the RCC slab. The side cladding shall be Single skin Metal cladding (from lowest working floor level till roof top) with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both sides. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. ~~Contractor shall have option to use Tubular steel sections for vertical & horizontal bracing~~s. Horizontal bracings at all platforms levels shall be designed as beam carrying axial force and bending moment to take care of loads from platforms for maintenance and Gravity Take-up.

Brackets and beams for supporting the Conveyor gallery portal shall be provided at required elevation on columns of Transfer Point.

Grade slab shall be provided for all transfer point houses.

Steel doors and sliding steel doors of required sizes as per system requirement for personnel access and handling of equipment respectively shall be provided.

The roof of Transfer points shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described in clause 9.08.00, Part-B (Civil) of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

For TP's in Main Plant Area, each down comer shall lead the water / coal slurry into the RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain (RCC drains with steel gratings provided around the TP), which will lead the discharge finally into plant effluent drain routed alongside the nearby road.

All stairs of over ground portion of transfer houses 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 electro-forged 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 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.

Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m2.

Out side stairs to transfer points shall be open type. However sheeting shall be provided at the top.

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.

Last TP in main plant area shall be designed and constructed to take care of loads due to future expansion of conveyor gallery.

Conveyor Galleries and Trestles in Main Plant Area

Troughed belt conveyors in Main Plant Area shall be housed in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

The maximum span of conveyor gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Contractor can also use tubular steel sections for roof truss of conveyor galleries only. The tubular steel section shall be of circular/rectangular/square shape. The circular steel tube shall conform to IS 1161 and rectangular/square steel sections shall conform to IS 4923. The steel structures using tubular sections shall be designed and fabricated as per IS 806 – “Code of Practice for use of steel tubes in general building construction.” and EN 1993-1-8:2005.

Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 MPa & 4.0mm respectively.

For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be of chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10 degrees, chequered plate steps with nosing and toe guard shall be provided. Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere.

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

Conveyor gallery supporting trestles located between transfer points / buildings shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer point, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer point structure and vice - versa.

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and 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 base shall be kept 1.2m below the finished floor level of ground floor of Main Power House.

d) MACHINE FOUNDATIONS IN MAIN PLANT AREA

Salient Features

The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials, springs & viscous dampers.

Turbo- Generator (TG) foundation:

Alternative-1

The TG foundation shall comprise RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns. These TG columns can be interconnected to the Main Power House Building frame either rigidly or connected through PTFE bearings on corbels/ brackets of the TG Columns. The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on TG Equipment detail of the Bidder.

Alternative-2

The TG foundation shall be conventional machine foundations comprising of RCC top deck directly supported on substructure comprising of columns and beams without any steel helical springs and viscous dampers. The columns shall be rigidly connected to the RCC deck at top and shall rest on open / pile supported foundation at bottom. The entire foundation system (including deck, columns and raft) shall be isolated from the main plant building structural system and no connection between the main plant structure and TG foundation is permitted.

Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

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 RCC/ 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 and Coal Mill foundations:

PA/ FD/ ID Fan and Coal Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. 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.

Design Concept:

a) For the foundations of Turbo-generator, Boiler feed pumps, Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done.

b) The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbo-generators, BFPs, etc.,

c) Wherever alternative-2 is adopted by the bidder for TG or BFPs, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.

d) The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid.

For detailed specification of steel helical springs and viscous dampers refer General Specification Chapter.

e) BOILER STRUCTURE

A. Salient Features

The Boiler supporting structure shall be structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions. The general arrangement & details of structural steel columns, beams, bracings, ceiling girders etc shall be as per the Bidders Boiler Structure design and detailed engineering scheme.

The bottom base plates of Boiler structure columns shall be 1.20m below the finished paving level in the Boiler area. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 350mm above the top of the paving RCC slab.

Bidder shall integrate the boiler supporting structure with Mill & Bunker Building Structure. Boiler Roof (Penthouse)/canopy/ side cladding shall have single skin trough-ed profile permanently color coated sheets.

B. Design Concept

Boiler supporting structure shall be designed by the Bidder based on working stress method for structural steel and IS: 456 for RCC.

f) MACHINE ROOM

Floor of Machine Room shall be provided with profiled metal decking sheet. Trough shall be filled with Insulating Material (glass wool or rock wool) and thereafter finished with Minimum 50 mm thick wooden flooring, consisting of 37 mm thick hardwood planks, finished with 11mm thick laminated wooden flooring (of 'pergo' or equivalent) with plank size 193x1195mm (material class shall be 34 as per EN13329), over 2 mm expanded polystyrene foam and polythene sheet under laying.

Roof and Side enclosure of Machine Room shall be provided with Prefabricated Insulated Metal Sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00 of Part-B (Civil) of Technical Specification.

Doors of Machine Room shall be Double Plate Steel flush doors of thickness 45 mm with steel sheets of 18 gauge with necessary stiffeners. Space between two sheets shall be filled with mineral wool insulation. Frame of doors shall be pressed steel sheets of 16 gauge. All necessary fittings for the doors shall be provided by the Bidder. Rubber sealing, for making the Doors airtight shall also be provided.

Windows/ventilators shall be of standard extruded AnodisedAluminium Sections of minimum 2 mm thickness with 24 mm hermitically sealed double glazing consisting of two 6 mm thick toughened glass separated by 12 mm. gap.

Technical requirements of prefabricated insulated metal sandwich panels/decking sheets shall be same as given elsewhere in this specification

g) Compressor House

(i) Salient Features:

The compressor house shall be a structural steel framed superstructure with a hand operated overhead crane of required capacity. The gantry girder for the crane shall have walkway with chequered plate on both rows and cage ladder access.

The roof shall comprise minimum 40mm thk RCC slab (with additional water proofing) supported on profiled metal deck sheet and purlins. The ground floor slab shall comprise of all RCC block foundations, cable trenches and pipe trenches. The building shall be completely covered with vertical cladding and roof.

(ii) Design Concept:

The Design of Compressor House shall be based on working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification.

Architectural Features

This building shall be steel framed structure with brick wall up to window sill height & Single Skin Metal Panel cladding above it. The roof system shall be as per the detail furnished in the salient features of this building

Cutouts and opening shall be provided in floors and walls as per requirements.

Metal Panel cladding shall be composed of different colour shades to match with the existing surroundings. External finish shall be of Premium Acrylic Smooth Paint with Silicone additives

The size, height, door/window/rolling shutter details and building size shall be as per the approved equipment layout plan of the bidder.

h) ESP structure:

Salient Features

The ESP structure shall be a structural steel superstructure with vertical bracings in the required vertical planes in both longitudinal and transverse directions, the details of which shall be as per the approved ESP equipment GA & details of the bidder.

The bottom of base plate for ESP structure columns shall be 300mm above the finished paving level in ESP area. The RCC pedestals supporting the column base plates shall be extended accordingly above the top of the paving RCC slab. Further, the gusset plate / base plate shall be encased in concrete up to the top of bolts.

Design Concept

Design of ESP structure shall be based on Working stress method. It shall be an axially braced structure in both orthogonal directions. The ESP supporting columns

shall be suitably strengthened about the minor axis for sliding movement of the base plate of ESP due to thermal movement.

i) ESP Control Building

(i) Salient Features

ESP Control Building shall be structural steel superstructure with RCC floors at ground floor level and upper levels. The RCC floors at upper levels shall support the Switchgears, cable galleries and Control Room. The RCC floors at upper levels shall be cast in situ RCC slabs supported on profiled metal deck sheet and structural steel beams.

The roof of the building shall comprise of minimum 40mm thick RCC slab supported on profiled metal deck sheet and structural steel beams. The rainwater down comers shall be as per specification and shall be suitably concealed.

The external Transformer Yard of the building shall comprise the transformer foundations and cable slit below ground level.

The building shall have Lift structure with lift pit below ground level and staircase at each gable end of the building.

(ii) Design Concept

The Design ESP Control Building shall be based on Working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification. However, bracings in any internal axis may not be possible due to functional requirement and columns in that row shall be designed for biaxial bending

ArchitecturalFeatures:

This building shall be Double storeyed Steel Frame structure & shall be completely covered with Light Weight Autoclaved aerated concrete panels on all four sides except for the portion in front of the external Transformer Yard. Provision for glazed/ fire proof doors & windows shall be included. Minimum 345mm thk brick wall shall be provided for the external brick wall facing the adjacent transformer yard and the brick wall height shall be 600mm above the highest point of the transformer. Inside the building, AHU rooms, UAF Room& Battery rooms shall have brick masonry of one brick thickness. The internal walls of air-conditioned area shall be finished with Aluminium Composite Panel Cladding.

Entire transformer yard, which shall be adjacent to the building, shall be provided with metal fencing with gates.

The building shall accommodate cable vault, toilet, staircase, switchgear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Control room and VFD room shall be air-conditioned and shall have false ceiling. Windows& Ventilators all shall be provided with Aluminium sections. All doors, windows in air conditioned area shall be provided with hermetically sealed toughened glass glazing in Aluminium frame work Steel doors and Fire proof doors shall be provided as per requirements. Internal columns in Control Room shall be encased with Aluminium Composite Panel cladding/ Laminated Board Panelling

Minimum 2 Nos. of stairs and 2 Nos. of Toilets shall be provided as per requirement. Cut-outs and opening shall be provided in floors and walls as per requirements.

External finish shall be of Aluminum Composite Panel Cladding .

j) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level.

k) Pipe & Cable Gallery

(i) Salient Features:

However, trestles for pipe and cable galleries shall either orf structural steel or concrete (Pre Cast) construction. Design, fabrication/ manufacturing of precast structural members like column & beams handling /erection and jointing there of shall be done as per IS 15916

The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick MS grating and 1.0m high handrail made of 32NB MS pipes.

Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum gusset plate thickness shall be 8mm for all connections.

The level of the bottom chord (bottom of steel) of the gallery shall be at least 3.0m above the finished paving level in general. However, at all road crossings, the level of bottom of steel of the gallery shall be at least 8.0m from the top of road surface and 8.5 m from top of rail track. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, up to the pipe/cable racks/trestles.

The Caged structural steel ladder shall be provided at an interval of 200m for access to the Pipe-Cable Gallery Walkway.

~~The total length of pipe cable gallery shall be between 4 km & 8km approximately depending on the plant layout developed by the bidder.~~ Suitable expansion gap shall be provided in the gallery structure by providing twin two-legged trestles at the expansion gap. The expansion gap shall be provided at an interval of 100 to 120m. Expansion gap shall also be provided at location where changes in plan dimensions (gallery width) take place abruptly.

At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 1.50m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from center line of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure.

The foundation for Pipe-Cable gallery trestles shall comprise RCC pedestals with footings. The footing base shall rest on virgin soil. In case virgin soil depth is high, the gap shall be filled with PCC (M10 grade). The grade of concrete for RCC footing & pedestals shall be M25. The structural trestles shall not be supported on paving RCC slab.

(ii) Design Concept:

The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter.

The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth.

The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level(on top of the trestle column). Deflection of end portal due to wind

shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly.

l) Service Building

This building shall be an RCC structure having RCC frame with RCC floors and roof slab. For the building, floor-to-floor height shall be as per architectural features. A connecting corridor with MPH building shall be provided at operating floor level. The building walls shall comprise aerated concrete blocks from ground floor to roof level. The grade of concrete for RCC frame (including foundation) shall be M25.

Architectural Features

This building shall be Five storeyed (Ground +4 stories above) and shall be provided with floor area of 4500sq.m with RCC framed structure. Autoclave Aerated Concrete Block masonry wall shall be provided for the full height of the building for both external and internal walls. Floor-to-floor height shall be minimum 4.25m. A connecting corridor with Main Power House building shall be provided at operating floor level. The floor of the connecting corridor shall have vitrified ceramic tiles, stainless steel hand rail & fixed windows. The connecting corridor shall have double skin metal cladding & insulated metal sheet sloped roof.

Hermetically sealed double glazing with toughened glass shall be provided for external glazing.

A minimum 70 mm margin for floor finish to be kept for provision of metallic raceway.

This building shall provide offices for Operation staff, Conference room for 50 persons, C & I Laboratory, Exhibition Hall, VIP Lounge etc. This will be fully air-conditioned building with adequate provision of toilets, pantry, cabins for senior executives and separate rooms forexecutives, supervisors etc. Lift structure with RCC lift pits shall be located inside the service building. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped on each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms. 2 no's of staircases and 2 no's of lifts with adequate capacity shall be provided. One store room shall be provided

Covered parking space for 10 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 45 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The service building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided

External finishing shall be of premium acrylic smooth exterior paint with silicone additives and Coloured Aluminium Composite panel combination.

5.02.00 Chimney

5.02.01 Salient Features

Single flue or Multi-flue chimney(s) shall be provided, catering to 3x800 MW units of the project. Chimney(s) shall be of reinforced concrete construction. There shall be one flue (liner) for each unit. The flue gas emission point shall be minimum 275 meters above the

plant grade level.

The chimney shell (windshield) shall be constructed using slip form shuttering. Internal platforms of steel structure shall be provided for enabling access to various elevations of the chimney and to provide support to the flue liners. Spacing of internal platforms shall not exceed 45.0 M. The platform beams shall be supported on concrete shell using suitable load bearing arrangement in the recesses provided for the purpose. The platform beams getting supported in the chimney shell shall have complete bearing support within the thickness of shell at that location and shall in no case be supported completely/partially on corbels/ brackets from the shell. "Through openings" in shell if provided ~~for supporting platform beams, the same shall be closed with closure wall made of RCC on the external face of the shell~~. Openings in the concrete shell for flue duct entry, access door & truck entry door at ground level, air ventilation etc shall be provided. Hand railing shall be provided all around internal staircase & around the ventilation voids in the internal platform using min. 32 mm nominal bore MS pipes of medium class conforming to IS:1161 ~~and shall be galvanized as per IS:4736 and finished with suitable paint as specified elsewhere in the specification. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes. All welding shall be done before galvanizing~~. Spacing of railing posts shall not be more than 1500 mm centre to centre with a minimum height of 1200 mm. The handrail shall have three rows of horizontal members between the railing posts including the top member. Kick plate of min. size 100x6 thick shall be provided in the hand railing.

to facilitate erection of platform beams shall be closed with cast-in-situ RCC closure wall on the external face of the shell. Necessary dowel bars shall be provided in the shell during construction for this purpose.

The flue duct outside the chimney shall be suitably connected to the flue liner inside the chimney through a transition duct. The transition duct shall be bottom supported and shall be profiled into a circular shape to connect to the flue liner. The flue duct shall be so designed that no load is transferred on the chimney shell due to the duct. The interface between the flue liner and the transition ducting shall be provided with non-metallic fluroelastomeric fabric expansion joint.

The expansion joint in the flue liner shall comprise of non-metallic fluoroelastomer material suitable to withstand a temperature of 300^{0}C, shall be acid ~~resisting~~ resistant to withstand acid flue gas condensate arising out of flue gas parameters & operating conditions as specified elsewhere in the specification and shall prevent dust accumulation. The space between the expansion joint material and the liner shall be packed and sealed by providing a bolster made up of light weight compressible material suitable to withstand a temperature of 300 Deg C and acid resistant to withstand acidic flue gas condensates arising out of flue gas parameters & operating conditions as specified elsewhere in the specification. The bolster shall be confined in texturized glass fabric having final covering of ~~of stainless steel wire mesh~~ stainless steel wire emsh.

Chimney roof shall be of RCC slab over a grid of structural steel beams and provided with rainwater drainage system. An internal structural steel staircase supported from chimney shell with chequered plate floor panels and pipe handrails, shall be provided for full height of the chimney and an internal cage ladder for a small height, over last staircase landing to access the chimney roof through a roof access hatch.

The other components of the chimney include liner test ports (for continuous pollution monitoring), liner hatches, grade level slab of RCC with metallic hardener floor finish, a large electrically operated grill type roll-up door and personnel access metallic door at grade level, roof drain basin, rain water down comer pipe (150 mm dia galvanized pipe), connection to plant drains, louvers with bird screens for ventilation and all other openings in the wind shield, galvanized mild steel strake (if required), all finishing works, electrical power distribution boards, lighting panels, power & control cabling and wiring systems, stair and platforms lighting, socket outlet, lightning protection and grounding system, aviation obstruction lighting with photoelectric controller etc, communication system, a rack and pinion elevator and other items, though not specifically mentioned but reasonably implied and necessary to complete the job in all respects.

Aviation Warning Lights (AWL) shall be mounted on door panel of required size (openable from interior of chimney shell) fixed to openings in the chimney shell at locations and levels specified elsewhere. Suitable provision for approach to the AWL shall be provided at the platform level. AWL shall be located at about 1-1.5 metres above the top of platform to enable easy handling for maintenance.

The size of roll-up door shall be determined based on minimum requirement for ventilation and transportation & erection of flue segments.

5.02.02 **Design Concept**

Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in Indian Standard, reference shall be made to ACI, BS, CICIND and other international standards.

In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail.

Imposed loading for design of all chimney components shall not be less than 5 KN/ Sq.m. An additional 25% of liner load shall be taken as impact loading for liner erection in addition to the liner load.

The min. thickness of web for plate girders shall be kept as 12 mm.

Seismic forces on the chimney system shall be determined based on site specific seismic information provided elsewhere in this document.

Wind forces on the chimney system shall be determined based on site specific wind design criteria provided elsewhere in this document.

The chimney and its components shall be designed to resist the most onerous forces resulting from all the possible combinations of the various loadings. Design of all chimney components shall be based on working stress method.

Wind Shield

The load calculation and load combinations shall be detailed in IS 4998 (Part 1): 1992.

The wind shield shall be designed for vertical loading, cross wind loading, seismic loading, circumferential wind loading, thermal gradients etc. ~~The various loading combinations shall be as detailed in IS:4998~~. The wind shield shall be analysed for cases with and without flue liner loads.

Forces/stresses in the wind shield due to eccentricity effects of local (e.g. corbel) loadings, insolations effects, rotation of chimney foundations, construction tolerances and moments of second order shall also be considered.

Seismic response of the chimney shall be computed by the response spectrum method. At least, the first five modes of vibrations shall be used for this analysis.

The cross wind analysis of the chimney shall be carried out irrespective of the value of the Scruton Number for the chimney and other empirical considerations which suggest structural immunity to cross wind oscillations.

The effect of the openings/cut-outs in the chimney shell shall be duly considered in the design of the windshield. The minimum thickness of shell shall not be less than 500mm.

The stresses for the shell design shall not exceed the limits given in Cl. 7.0 of IS:4998 (PART-I) 1975 for various combinations of loads, excepting the stress in concrete for the case of dead load + wind load which shall not exceed 0.30fck where fck is the characteristic compressive strength of concrete.

The minimum vertical reinforcement shall be 0.3% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 250 mm on each face. The minimum circumferential reinforcement shall be 0.2% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 200 mm on each face. The circumferential reinforcement in the top 3 meters of the windshield shall be twice that required from design forces. The clear cover to reinforcement shall be 50 mm.

There shall be a continuous ring of concrete shell without any opening for a height of atleast 5m below the soffit of flue duct openings.

There shall not be any reverse (outward) slope in the inside face of chimney shell. Where there is a sudden change in slope/ profile of the shell, the circumferential reinforcement shall be increased to twice the requirement as per the design in a circumferential band extending atleast 3m above and below such slope/profile change level.

The diameter of the reinforcing bar for the main vertical reinforcement of shell shall not be less than 25mm for a shell height upto the top level of flue duct opening.

Shell thickness between any two 10m reference levels shall not vary more than 150mm.

The minimum thickness of shell/closure wall at beam support recess/ opening locations shall be 100mm.

Grade of concrete for chimney shell, and other super structure shall be minimum M 30. Only OPC cement shall be used for Chimney shell and other super structure.

The final design shall be checked & verified by 'Wind Tunnel Test' and shall be conducted at a reputed institution. Dynamic interference effects due to additional chimney(s)/NDCTS's and other tall structures located in the area or in the future expansion stage of the project shall be determined along with the other topographical features of the local area through model test.

Flue Liners

The chimney flue liner cladding shall be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner. Cladding shall be done to achieve the required quality as per ASTM B 989-11. External surface of chimney shall be wrapped with 2mm thick Titanium / C-276 sheet over insulation.
The stack shall be designed as per the latest guide lines of EPRI Wet Stack design Guide. The design of wet ducts and stacks system shall consider the Stack liquid discharge (SLD), corrosion/ chemical attack, condensate collection system and its drainage etc.

The flue gas parameters & various operating conditions for selection of flue liner and the criteria of flue gas exit velocity for sizing the flue liner shall be as specified elsewhere in the specification.

~~The flue liner thickness shall be determined from functional and structural considerations. However, the minimum thickness of the flue liner shall not be less than 10 mm.~~

For flue liner with base metal as mild steel, the thickness of the base metal shall be determined from structural considerations. The thickness of any clad metal/coating/lining etc. provided on the base metal shall not be considered for computing the structural strength of flue liner. The minimum thickness of the mild steel base metal shall, however, not be less than that specified elsewhere in the specification.

Two manholes placed diametrically opposite shall also be provided in each flue at all internal platform levels.

The supporting/restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

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

Internal Platforms

The platforms shall be designed for dead, imposed (live), erection work and other possible loadings and temperatures effects. These platforms shall provide support and lateral restraint to the steel liners and provide access for inspections and maintenance. Forces imposed on the floors due to lateral restraint of flues shall be enhanced aptly for impact effects. These platforms shall also be designed suitably for the liner erection works. The platform shall be made up of chequered floor panels supported on grid of structural steel beams. All beams shall have bolted connections. The maximum permissible deflection in main steel girders supporting flue liner shall be span/1000.

Internal Staircase

and a clear headroom of not less than 2100mm.

The staircase shall have a clear passage way width of not less than 800 mm. The riser height shall not be more than 175 mm and tread width shall not be less than 225 mm.

Foundation

The chimney foundation shall be designed for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney

system during all stages of constructions. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There should be no uplift under any portion of the foundation for any loading condition. Since chimney is a wind sensitive structure no allowance shall be made in the load carrying capacity of the bearing strata / piles under any load case/combination with wind. No allowance shall be made in the stresses for design of foundation for wind loading. The foundation diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12. The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall not be less than 25mm. The spacing of radial steel at the outer edge of the foundation shall not be more than 250mm. Grade of concrete for foundation shall be minimum M 25.

Thermal insulation

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin bonded rock wool. The coefficient of thermal conductivity of insulation shall not be more than 0.52mW/cm/oC at a mean temperature of 100oC.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55 degree Celsius. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness.

The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer-most surface with galvanised wire mesh using MS galvanised pins and speed washer.

Chimney Painting

(i) All exposed steel surfaces (~~including exterior surface of mild steel flue liner~~) except surfacesof steel wind strakes shall be painted as specified in corrosion protection clause of this specification.

(ii) All exposed surfaces of steel wind strakes shall be painted with epoxy phenolic coating system having total 240 microns DFT.

a) All steel surfaces shall be provided with two component epoxy primer coat (having solid by volume minimum 51% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique.

b) Primer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied in shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

(iii) All steel parts embedded in concrete like Strake embedment assembly including bolts, nuts, washers, pipe sleeves and insert plate shall be galvanized as per IS:4736. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes.

(iv) The inside surface of chimney shell above roof, horizontal surface of sheel at top, underside of concrete roof slab, external surface of minishell above roof etc shall be painted with epoxy phenolic coating system having total 220 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied ~~in shop~~ after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

(v) The top 50 M of the external surface of chimney shell shall be painted with epoxy phenolic coating as specified in (iv) above in alternate bands of 'signal red' and 'bright white' colours.

(vi) The balance external surfaces of chimney shell with aliphatic acrylate system having total 170 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 100 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied ~~in shop after an interval~~ of after an interval of minimum 24 hours (from the application of sealer coat). Colour and shade of the coat shall be as approved by the Employer.

Electrical System

415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply.

Ambient temperature for design of all equipment shall be considered as 55 deg. C which is likely to be encountered inside the chimney. The equipment shall be suitable for installation and render trouble free operation at higher ambient temperature and rigorous weather conditions prevailing at chimney.

All equipment supplied shall comply with relevant IS Standards.

The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from

normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source.

Dry type isolating transformer of Dyn connection shall be provided in emergency board to obtain neutral lead, in case 3 phase 3 wire emergency supply is derived from main plant.

Various platforms shall be illuminated by dust tight HPSV well glass lighting fixtures. Average illuminations level of 150 lux shall be maintained on equipment and 70 lux on platforms & 100 lux on staircases (minimum 1 lighting fixture at each landing).Any additional fixture to take care of dark patches/shadows shall also be provided. Lighting system shall be controlled through MCB provided in lighting panel.

A lighting and power panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 20A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminium wires through galvanised steel conduits.

Aviation obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA). The type of aviation obstruction lighting system shall be of high intensity aviation obstruction lights having an effective intensity of 4000 to 2, 00,000 cd depending upon back ground illuminance. Obstacle lights shall have a day time effective intensity of minimum 200000 cd. The intensity of lights shall reduce automatically to 20000 cd ± 25% at twilight through the use of photocell and again automatically to a night time intensity of 4000 cd ± 25% through the use of photo-cell. The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute. A minimum of three levels will be provided with aviation obstruction lights and there will be four light units per level. The lowest level should not be lower than 70 meters above the ground and vertical spacing of the intermediate levels could vary between 70 and 105 meters. Aviation obstruction lighting shall be complete with lights, photo cell, controller, special cables, etc.

A temporary aviation obstruction lighting system shall be provided during construction of the chimney.

Cables from distribution board to lighting panels/power panels/receptacles shall be 1100V grade, multicore FRLS HR-PVC insulated, PVC inner sheathed, armoured, PVC outer sheathed stranded copper/ aluminium laid on galvanised sheet steel cable trays. Cables shall be terminated using double compression type cable glands and solder less crimping type tinned copper cable lugs. Minimum size of the power cable shall not be less than 2.5 sq.mm copper or 4 sq.mm aluminium. Minimum size of control cable shall not be less than 1.5 sq.mm.

Lightning protection system shall comprise minimum 3 vertical air terminations for each flue liner, horizontal air terminations and minimum 4 Nos. of down conductors spaced 90 degrees apart routed all along chimney height on external surface and connected to the earthing system. Down conductors shall be of minimum 50x6 mm galvanized steel strip. Each down conductor shall be provided with a test link at 1 metre above ground level. Each test link shall be enclosed in a galvanised sheet steel enclosure. Above ground level earthing and lightning protection system shall comprise galvanised steel strips. These materials provided at top 12 meters shall have additional coating of 2 mm thick seamless lead cover and the accessories like nuts, bolts, washers etc. shall be of stainless steel to take care of corrosion. Chimney earthing system shall be interconnected to main plant earthing system.

A temporary lightning protection &earthing system shall be provided during construction of the chimney till a permanent lightning protection &earthing system is installed. In no case reinforcement bars of Shell should be used as earthing Down Conductors

Communication system comprising of telephone socket at every internal platform level and at grade level, necessary wiring installation, a telephone hand set, junction boxes etc. shall also

be provided. Telephone cables shall be of minimum 0.6 mm dia annealed high conductivity electro copper conductor, PVC insulated, twisted, PVC tape wrapped, screened, rip corded, PVC sheathed, conforming to relevant ITD (Indian Telephones Department) specifications.

All equipment to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all type tests as listed below:

(A) Distribution boards/panels-Degree of protection tests

(B) Aviation lights:

(1) Intensity Test

(2) Degree of protection test

For various equipment, the technical requirements and practices shall conform to the relevant clauses of the main plant electrical specification.

Rack and Pinion Elevator

A rack and pinion elevator, with a load carrying capacity of 400 kg (min) (passenger cum goods), cabin floor size of 1100 mm x 1000 mm (min.) and an operating speed of 40 m/min. (approx.), shall be provided for travel from the grade level to the top of the chimney. A landing platform shall be provided at all access/ platform levels. The elevator shall be of a proven and approved make. Enclosure shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high (Approx.). A Safety device comprising of an over speed governor in constant mesh with the rack by means of a flame hardened steel pinion shall be provided to protect the cab against over speed during the cab downward motion and the same shall actuate the brake mechanism and stop the down ward motion gradually. The lift shall be installed using anchor fasteners. The electrical requirement of the system shall conform to the main electrical specification. Drive motor shall be of S3 duty class with CDF of 25% and maximum number of 120 starts per hour in 55 degree Celsius ambient temperature. The motor shall be provided with internal 220V AC single phase space heaters or an alternate heating system. The elevator shall be supplied, installed, painted, tested, commissioned etc. complete with all mandatory spares (as specified in Part-F of this specification) and operation maintenance manual.

5.03 **Auxiliary Cooling Tower**

5.03.01 **RCC/FRP Auxiliary Induced Draught Cooling Towers**

The civil works for cooling towers are related mainly to following areas, but not limited to:

5.03.01.01 **Cooling TowerBasin**

The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M - 30 grade as per IS: 456). The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed concrete of grade M-15 as per IS:456 having minimum thickness at edge as 25 mm. Drainage arrangement of basin shall be as specified elsewhere in the Technical Specifications. If the cooling tower basin and sludge sump is below ground level, FRP handrailing shall be provided all around the cooling tower basin and sludge sump pit.The bottom 500 mm of handrailing shall also have FRP/PVC wire mesh with opening size of 50mm grid to avoid ingress of leaves, vegetation, and debris into the basin. The basin shall be tested for water tightness as per IS:3370.

~~Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for un-cracked section as per IS:3370~~.

Hot water duct around cooling towers, if placed below ground shall be encased with min. 500mm thick PCC (M20 grade).

a) Foundation of Cooling Tower

The foundation of the Cooling Tower shall be as detailed out elsewhere in the specifications.

b) Super Structure of Cooling Tower (applicable in case of RCC cooling tower)

Columns, beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M-30 (minimum) as per IS : 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.

The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1 : 120 (min.). The slope shall be provided with screed concrete of grade M-15 (minimum) as per IS : 456.. Fan Deck slab and all other over ground platforms shall be provided with FRP handrailing. Suitable arrangement for drainage of rain water to be provided. However, there is no specific requirement of Rain Water down comers.

c) Cells, Distribution System and Stack (applicable in case of RCC cooling tower)

Cooling tower cells shall consist of RCC columns, beams and walls. The spacing of columns shall be minimum 4000 mm c/c. Inclined bracings shall not be provided between the columns. Hot water distribution channel shall also be of RCC. Cell division partition walls shall be of precast solid concrete blocks with provision of pilasters for walls, if required. The peripheral wall shall be Cast-in-Situ RCC wall and shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8 mm and maximum spacing as 150 mm c/c. Minimum thickness of Cast-in-Situ RCC peripheral walls shall be 200 mm.

Hot water channel shall be covered with suitably designed precast / cast - in - situ concrete slab. Wherever flow control valves are located over hot water basin, these shall be placed over precast concrete covers / concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150 mm. The fanstack shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 200mm c/c.

d) Stairs

FRP staircase for approach to fan deck for each cooling tower shall be provided. The stairs shall have 1000 mm clear width and FRP handrailing. The riser shall be maximum 175 mm & treads 250 mm (minimum).

e) Steel Structures

~~All mild steel parts of structures used in cooling towers shall be hot dip galvanized or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). The minimum coating for galvanization shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of SS 316.~~

f) Water proofing of structures and construction joints

For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. In addition Chemical injection treatment shall be provided for the construction joints of all underground structures.

g) Expansion Joints

PVC sealing strips shall be used for all expansion joints where water is retained. The minimum thickness of PVC sealing strip will be 6 mm (minimum) and minimum width 225 mm. The expansion joint shall be as per IS: 3370. At expansion joints, joints filler material with sealing compound on both sides shall be provided throughout the length of the joint.

h) Grade of concrete

All RCC associated with induced draught cooling towers including switchgear and control room, unless specified otherwise, shall be design mix (controlled) concrete of grade M 30 of IS: 456. Water - cement ratio shall not exceed 0.45.

Minimum 75 mm thick PCC of grade M-7.5 as per IS: 456 shall be provided as mud mat below foundation unless specified otherwise. The PCC shall extend 75 mm beyond the outer edge of structural concrete.

For water retaining structure minimum 100 mm thick PCC of grade M-10 as per IS:456 shall be provided as mud mat below the bottom slab / raft. The PCC shall extend 100 mm beyond the outer edge of the structural concrete.

i) Form-Work

Plywood Form-work shall be used for basin, basin walls, outlet channel and super structures (if applicable).

j) Doors

FRP door shall be provided in each fan stack at fan deck level. Door height & width as per requirement for equipment movement (clear) shall be provided. However, door size shall be minimum 2100 mm high (clear) & 1200 mm wide (clear). Door shall have locking facility.

k) Coating

All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in **Annexure-H.** All concrete surfaces subject to water/ water spray/moist air upto and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower), etc as applicable shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in **Annexure-H.**

External surfaces of Cooling tower peripheral walls and fanstack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color. (applicable in case of RCC cooling tower)

l) Paving

Paving shall be provided for a minimum clear width of 5.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher. The minimum total width of paving around CT basin shall be atleast 8.5 m from outer edge of the spray catcher or basin wall. Paving shall consist of reinforced concrete base slab laid over 75 mm thick PCC of grade M-10 as per IS:456 sub-base and 200 mm thick stone soling. The sub-base shall be laid on the compacted and suitably prepared sub-grade. The degree of compaction of sub-grade shall be as specified elsewhere in the specification. The thickness of the RCC base

slab of grade M - 25 shall be suitably designed considering a superimposed load intensity of 5T / Sq.m. However the minimum thickness of base slab shall be not less than 150 mm having double layered reinforcement in both directions both top and bottom. The maximum spacing of the reinforcement bars shall be 150mm c/c and minimum dia of reinforcement bars shall be 8mm.

RCC peripheral drain of minimum cross sectional dimensions 300mm X 300mm to dispose storm water shall be provided around area paving and shall be connected to nearest Owner's storm water drain.

m) <u>Walkways (applicable in case of RCC cooling tower)</u>

Permanent walkways at least 1000mm clear width shall be provided at hot water distribution level and at drift eliminator level for counter flow type cooling towers. The clear working height available above these walkways shall be at least 2.0 meters. The walkway and its supporting structure shall be of RCC M - 30 grade. Suitable RCC guards rails 300 mm high shall also be provided on both sides of these walkways. Over the guards rails FRP handrailing shall be provided. The vertical post of handrail shall be 700 mm high and at an interval of 1500mm c/c. There shall be two levels of horizontal pipes for hand railing spaced equally in vertical plane.

Permanent walkways at least 1000 mm clear width shall also be provided for access to fan and around gear box with FRP gratings of clear opening size not more than 50 MM x 50 mm and grating thickness of 50 mm on RCC supports at fan deck Level.

5.03.01.02 Design Criteria

R.C.C. Structures

(a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009. These structures shall be designed for following conditions :-

1. Water filled inside upto the designed level and no earth outside.
2. Earth pressure plus 2.0 T / M2 surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

(b) The design of all structures other than liquid retaining/conveying structures of cooling tower above CW basin slab such as columns, beams, fins, walkways, slabs, cladding/partition wall, fan stack, precast beams etc. as applicable shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2): 2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3.

Wherever, the foundation raft of cooling tower is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the cooling tower foundation is not the same as the CW basin slab and a separate foundation for the cooling tower is provided below the CW basin slab due to founding level requirements, the basin slab shall be designed as a structural slab resting on grid of beams taking support from columns or as a flat slab taking support from columns. Arrangement with providing walls between the columns and the periphery to support the structural basin slab is not permitted. The CW basin slab (both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 andthe structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab upto foundation shall be maintained same as the size of the columns just above CW basin slab..

(c) The design of staircase, switchgear building, control room/RIO room, transformer and trestle foundation, storm water drain shall be as per IS: 456 (2000).

(d) The Cold Water basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370.

(e) Fan deck shall also be designed for rolling loads due to movement of equipment during Installation / maintenance operation.

Minimum Clear cover for all RCC structures/elements of cooling towers to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000).

Fan Supporting Structures <u>(applicable in case of RCC cooling tower)</u>

<u>Static Analysis & Design</u>

The following load conditions and load combinations shall be considered for the design of the Fan supporting structures.

(a) Machine Load

(b) Load case (a) + unbalance load for the balance of the fan corresponding to G16 as per ISO 1940-1: 2003

(c) Load case (a) + unbalance load corresponding to one blade failure load condition.

The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above.

<u>Dynamic Analysis</u>

(a) Free vibration analysis

A free vibration analysis of the fan supporting structure including the intermediate supporting structure for motor, gear box and pillow block (if applicable) shall be carried out to calculate the natural frequency of the fan supporting structure and its fundamental natural frequency shall be at least + 20% away from the operating speed of the fan and motor.

(b) Forced vibration analysis

Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition : -

1. For unbalance load corresponding to G16 as per ISO 1940-1: 2003
2. For unbalance load corresponding to one blade failure condition.

The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent.

Mid Bearing Supporting Structure

The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns.

Fan Stack (applicable in case of RCC cooling tower)

The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS : 11504 for Natural Draught Cooling Towers. The fanstack shall have two layers of reinforcement on either surfaces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c.

Steel Structure

(except structural steel parts for stop-log gates and trash racks)

All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanised as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent.

All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints

For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as specified in corrosion protection clause. However, for painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting specified elsewhere in the technical specification shall be referred.

The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers.

Test for water tightness

The water tightness of C.W. basin, outlet channel, hot water channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS : 3370.

5.03.01.03 LOADING

For consideration of loads on structures and load combinations IS : 875 (Part -1 to 5) Code of Practice for design loads (other than Earthquake) for Buildings and Structures shall be followed.

Site specific seismic data and wind data shall be followed for design of cooling towers.

Live Loads

The following live loads (minimum) shall be adopted for the design of buildings and structures associated with Cooling Towers:

a)	Roof / Fan deck	500 Kg / Sq. M.
b)	RCC Floors	500 Kg / Sq. M.
c)	Stair, landings	500 Kg / Sq. M.
d)	Chequered& Grating floor	400 Kg / Sq. M.
e)	Basin, sump and duct	Earth pressure; water pressure as applicable and additional surcharge load of 2.0 T/Sq. M.
f)	Covers for H.W. channels / H.W. distribution basin	300 Kg / Sq. M.
g)	Walkways inside cooling towers	300 Kg / Sq. M.

	h)	Underground pipes and ducts	Earth pressure and surcharge load of 2.0 T / Sq. M.

5.03.02 STOPLOG GATES AND TRASH RACK FOR COOLING TOWER

Stoplog gates

The stoplog gate shall cover the clear opening of the cold water channel and effectively stop the water leakage. Clear size of the stoplog gates shall be equal to the clear opening size (freeboard of minimum 300mm over the maximum water level in stop log depth shall be ensured.). The capacity of the hoist (Min 2 ton capacity) shall be decided to match with provided size units of the stoplog gate. Structural design of stoplog gate shall conform to IS : 5620 and IS : 4622 (latest). Maximum water level for designing the stoplog gates shall be taken as maximum water level in the CT basin.

Stoplog gate and its lifting arrangement shall designed for a condition when basin is empty and water upto full level on the other side. Proper rubbers seal shall be provided in the stoplog to avoid any leakage of water.

Painting Specification for Structural Steel parts for stoplog gates and trash racks:

(i) All structural steel surfaces shall be cleaned by shot blasting.

(ii) All MS structural parts shall be galvanised to minimum coating of Sealed Zinc spray (250 Micron) as per BS:5493.

(iii) Over zinc coating one coat of zinc Phosphate Epoxy primer having minimum 30 micron DFT and three coats of coal tar Epoxy paint having minimum 75 micron DFT / coat shall be provided. Total DFT of epoxy paint including primer shall be minimum 250 microns.

Leakage Tests of Stoplog Gates

Leakage tests shall be carried out with the stoplog gates lowered onto the sill. Before observation for leakage, the stoplog gate shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 Liters / Minute / Meter length of seal under maximum head.

Material Specifications of stop log gate

All material used in the fabrication of stoplog gate shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Contractor, if asked for by the Employer.

Materials for the various components of Stoplog gates

Sl. No.	Component Parts	Recommended Materials	Reference
1.	Stoplog Gate Leaf	Structural steel	IS : 2062
2.	Stoplog Gate Frames and 1st stage embedded parts	Structural steel	IS : 2062

3.	2nd stage embedment	Stainless steel	SS 316L or IS : 1570 (Part 5).
4.	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)	Cast steel	IS : 1030
5.	Wheel axles, wheel track	Corrosion resistant steel.	IS : 1570
6.	Seals	Rubber	IS : 11855
7.	Bearings	SKF of equivalent	04 Cr 19 Ni)
8.	Seal seats	Stainless steel	SS 316 L or IS 1570 (Part -5)
9.	Lifting pin	Stainless steel	IS 1570 (04 Cr,
10.	Guide	Corrosion resistant steel	IS : 6603
11.	Guide shoe	Structural steel	IS : 2062
12.	Counter sunk bolts	Stainless steel	IS:1570 (Part 5)

TRASH RACKS

Materials, Manufacture and Design

Material Specifications:

All materials used in the fabrication of equipment required shall be new and shall conform to the requirements of specifications and codes as applicable referred herein. If a material is specifically not referred to in these specifications/specification drawings, Contractor shall furnish material of the highest standard commercial quality suitable for the intended use.

The material referred to in the design and drawings mostly conform the Indian Standard Specifications unless otherwise stated:

Materials for Trash Racks

S.No.	Component/Part	Recommended material	Reference
1.	Trash rack and embedded parts	Structural Steel	IS-2062

2.	Slide block	Structural Steel with bronze padding	IS-2062 and IS:305
3.	Track base	Stainless Steel	SS 316L or IS : 1570 (Part 5)
4.	Track	Stainless Steel	SS 316L or IS : 1570 (Part 5)
5.	Guides	Corrosion resistant Steel	IS : 6603
6.	2nd stage embedment	Stainless steel	SS 316L or IS : 1570 (Part 5)

2.Minimum Draw Down Level = RL(+)387.7m
3. Centerline of existing header pipe = Approx. RL (+) 382.00m.
Associated civil works include civil works of Civil works associated with Make-up water _PT and Makeup water-Ash pump house. Including pump foundations, sumps, Cable trenches/cable tray supports, pipe supports, grade slab & area paving, pedestals/thrust blocks for pipes(both inside and outside the plant boundary), arrangements for Makeup water pipe crossing at nallah/river/road/rail/drains locations and other associated civil works as per system requirements. The details and design criteria of water retaining structures like sumps, channels etc. associated with Makeup water pumphouse shall be as specifed clause No 5.05 of this chapter.

Design

Trash rack should be designed for 2.0m differential head as per IS:800 and also conform to IS:11388 (latest). Each unit of trash rack shall be consisting of vertical flats and horizontal flats. The grating shall be pressure locked. Size of opening shall be 100 mm x 100 mm for all trash racks.

All trash rack should be capable of being lowered in the associated stoplog gate grooves to enable drawl of clean water while a particular track rash is raised for cleaning purposes.

~~Trash racks shall be hot dip galvanized as per IS:4759 with 610 gm/sqm coating. Alternatively, trash racks shall be painted with scaled spray zinc coating conforming to BS:5493 (Table – 3, Part 8) for very long (20 or more) years of maintenance interval.~~

5.03.03 Switch Gear / Control Room for Cooling Tower

It shall be single storied building, framed RCC structure with beams, columns, floor and roof. It shall have non-load bearing brick wall cladding. It shall house the switch gear and MCC of cooling tower & associated cable trenches. It shall have toilet block with drinking water facility. The architectural features shall be as specified elsewhere in the specification.

5.04 ACW SYSTEM AND MAKEUP WATER SYSTEM

5.04.01 Open pumphouse including pump foundations, cable trenches/cable tray supports, pipe supports, grade slab & area paving, gantry crane pedestal and other associated civil works as per system requirements shall be provided for ACW system.

5.04.02 Suitable arrangement shall be made for interconnection of Makeup water pipes with existing header downstream of intake chamber (situated near spill way of Patratu dam and laying of make -up water pipe line up to PT plant and Ash handling plant. Any dismantling works required for enabling interconnection shall be carried out carefully to prevent damage to other nearby structures/ares and without disturbing the existing system operation. A closed valve chamber with locking facility shall be provided near the interconnection point for housing the valves provided in the Makeup water pipes under bidder's scope.
Salient features of Patratu Dam are as follows:
1. Maximum water level = RL(+) 406.14m

5.05 Water & Effluent Treatment Plant and CPU Civil Works

5.05.01 Design Concepts for Buildings/ Shed

i. All buildings shall have framed super structure.

ii. Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and on all sides. However, kerb wall shall be provided all around the plinth/ floor area above the Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided.

iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.

5.05.01.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.
5.05.01.02	The load and load combinations and design criteria shall be as specified elsewhere in the specification.
5.05.01.03	All liquid retaining structures shall be designed for following load conditions. Underground structures: a. Water filled inside up to design level and no earth outside. b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside. c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure. d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table. For design of over - ground liquid retaining structures appropriate load cases shall be considered.
5.05.01.04	All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2):2009.
5.05.01.05	In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.
5.05.01.06	Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.
5.05.01.07	Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.
5.05.01.08	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
5.05.01.09	The minimum grade of concrete for all RCC structures shall be M30.The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to severe exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.
5.05.01.10	Factor of safety against overturning and sliding The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.
5.05.01.11	For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.
5.05.01.12	Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.
5.05.01.13	Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows:

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars
a)	Foundation	12 mm	12 mm
b)	Beams	12 mm	8 mm
c)	Columns	12 mm	8mm

5.05.01.14 Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.

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

5.05.01.16 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.

5.05.01.17 Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.

5.05.01.18 Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.

5.05.01.19 Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.

5.05.01.20 All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere.

5.05.01.21 All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.

5.05.01.22 2.0m wide walkway with concrete paving shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL.

5.05.01.23 Coating on RCC water retaining structures (other than drinking water)

Epoxy phenolic coating shall be applied on (i) internal surfaces of the RCC water retaining structures and (ii) external surfaces of RCC Neutralisation-pit which is in contact with earth, as per details specified below:

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%) of minimum 400 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

5.05.01.24 Coating on RCC water retaining structures (drinking water)

Internal surfaces of RCC water retaining structures shall be provided with minimum 400 micron Food grade epoxy coating complying to FDA Title 21, Part 175.300. Surface to be coated shall be absolutely dry, clean and dust free.

5.05.01.25 **Architectural Concepts and Finishing Schedule**

Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.

5.05.02 **Acid / Alkali Resistant Treatment:**

Acid / alkali resistant lining treatment shall be provided in different areas as follows:

Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick A.R. bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification.

The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R.bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted.

The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron).

Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby.

Alum/Lime Storage area and first floor of Chemical House : One coat of bitumen primer followed by 12mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick underbed of potassium silicate mortar, 6mm thick pointing of joints of tiles with acid /alkali resistant epoxy /furane mortar up to a depth of 20 mm and bitumastic end sealing.

Alum solution preparation tank: The wall shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 75 mm thick A.R. tiles, 6 mm thick underbed by potassium silicate mortar, pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing.

The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer.

Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer.

Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.

Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.

Lime tank: Two coats of bitumen paint conforming to IS : 9862, with total DFT 150 microns.

Guarantee

The Contractor shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later.

The Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

5.05.03 Foundation of overground steel circular water storage tanks

5.05.03.01 General Requirements

The tank foundation shall be as per IS:803 and as specified in relevant clause of foundation chapter.

5.05.03.02 Sub Grade Preparation

The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).

5.05.03.03 Anti Corrosive Layer

Anti-corrosive layer shall consists of 75mm thick Bitumen aggregate mix on top and compacted soil fill below. The bitumen-aggregate mix shall consists of compacted crushed stone , screenings, fine gravel, clean coarse sand (river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted.

Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.

The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.

Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.

5.05.03.04 Premix Deleted

Materials

Sand

Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).

Stone Chippings

Stone chippings shall be hard black trap or granite or approved locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.

Bitumen

Bitumen required for the work shall be 80/100 grade or its equivalent quality.

Laying

Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.

The Binder bitumen 80/100 shall be heated to the temperature of about 190^0 C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.

5.06 **Switchyard Civil Works**

5.06.01 **Civil works for GIS and AIS includes:**

a. Towers, girders, lightning masts (if provided) and equipment supporting structures including proto type assembly etc.,

b. Foundations and supporting pedestals for towers, lightning masts (if provided), equipment supporting structures etc.,

c. 765kV GIS building, 132kV GIS building and Switchyard control room building.

d. Foundations for transformers and reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers / reactors, rail track, jacking pad and fire walls as required, arrangement for cabling etc. all complete

e. Earthing mat, single lane roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,

f. All necessary embedments, inserts, supporting structures & supporting members as required etc.

g. Cable trenches in switchyard and inside GIS building/Control room building including civil works for panel fixing etc.

5.06.02 **Design Criteria**

5.06.02.01 Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to IS 2062 and duly galvanized conforming to IS: 2629 and IS 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS 12427 and of property class 5.6 as per IS 1367 (Part 3). Nuts shall conform to IS 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS 5624 and property class shall be 4.6 as per IS 1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.

The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc.

5.06.02.02 Switchyard structures shall be designed for the worst combination of 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 (Vb) and terrain category as stipulated in “Criteria for wind resistant design of structures and equipment”.

b. All other structures shall be designed as per IS 456 / IS 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in “Criteria for wind resistant design of structures and equipment”.

4) Seismic loads,

5) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in

horizontal plane and ± 20 degree deviation in vertical plane),

6) Loads due to unbalanced tension in conductor/wire,

7) Torsional load due to unbalanced vertical and horizontal forces,

8) Erection loads,

9) Short circuit forces including snap in case of bundled conductors, etc.

Note:

i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.

ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures

iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.

iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.

v. The distance between terminal and dead end gantry shall be taken as 200 meters.

5.06.02.03 **Factor of safety:**

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition. Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition. For calculating restoring moment, weight of earth on footing pad without any inclination on sides shall only be considered.

5.06.02.04 **Design consideration for switchyard equipment support:**

The supporting structure for B.P.I., LA, CVT & Isolator equipments shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 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, for 400kV structure shall be 250NB, for 220kV and 132kV structures shall be 200NB and that for 66kV and 33kV shall be 150 NB.The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802.

Common raft foundation shall be provided for each pole of isolator.

5.06.02.05 **Special design consideration for lightning Mast:**

Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an\ ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m2 above platforms shall be considered for design of Lightning Mast.

5.06.02.06 **Design Criteria for structures not covered under Cl. 5.06.02.01 to Cl. 5.06.02.05**

The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of

	rooms/facilities/ equipment/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes. The design of RCC structures shall generally be carried out using limit state method of design as per IS 456. The minimum grade of concrete shall be of RCC M25 as per IS 456. The GIS building shall be a Steel framed superstructure with external wall cladding and roof sheeting of 0.6mm bare metal thickness. However, brick cladding shall be provided up to a height of 900mm from Finished Floor Level (FFL). GIS building shall consist of rooms/facilities/equipment/EOT crane as per system requirement. Design of steel superstructure shall be carried out by IS:800 and other relevant IS standards..
5.06.03	The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.
5.06.04	The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS 802 and IS 800. All materials shall be completely shop fabricated and galvanised.
5.06.05	All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Minimum section thickness should not be less than 4 mm. Weight of zinc coating shall be at least 0.610 kg/m2 and foundation bolts shall have heavier zinc coating at least 0.80 kg/m2.
5.06.06	**Cable Trenches** Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and ~~shall not be more than 65 kg~~. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o/p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.
5.06.07	**Stone Filling:** Stone filling shall be provided as specified elsewhere in the specifications. Each layer shall be compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling. Before laying the stone fill, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed/soil sterlization 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 sterlization such as manufacturer's name, their specification, test certificate, etc., for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the Bidder at no extra cost to the Employer. The Bidder shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.
5.06.08	**Transformer/reactor foundations** Foundations of transformers/reactors shall be designed for seismic and wind loads. Block foundations shall be provided for the main transformer block.

The oil soak pit, if provided, shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store complete oil of the transformer/reactor along with 10 minutes of fire water considering only 40% of the volume as available voids between Stone-filling. However, in case a separate oil collection tank is provided for the transformer/reactor, oil soak pit of volume equivalent to one-third (1/3) the oil volume of transformer/reactor shall be provided around transformer/reactor. The oil collection tank, in such cases, shall be designed for an effective capacity of complete oil of the transformer along with 10 minutes of fire water. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.

RCC Firewall shall also be provided between the transformers wherever required.

300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of Stone filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.06.09 The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.

5.07.00 COAL HANDLING PLANT

It includes the Civil, Structural and Architectural works related mainly to the following areas (but not limited to):

5.07.01 Track Hopper, Wagon Tipplers, Underground TP's & Tunnel

Track hopper and machinery hatches shall consist of underground portion, which shall be of R. C. C., and above ground portion, which shall be of structural steel shed covered with permanently Colour coated profiled steel sheets.

A continuous slit of 2 m high from bottom shall be provided all along the length of shed (excluding machinery hatch). Structural shed shall also be provided with ventilation arrangement with louvered windows at top.

~~The structural arrangement to be adopted for the design and construction of underground portion of track hopper and machinery hatches shall be as shown in tender drawing. It~~ essentially consists of R. C. C. frames spaced at approx. 3.0M centers with R. C. C. wall panels on the sides and R. C. C. raft at the bottom, fixed to the frames. The top beam of the R. C. C. frame supports the rail supporting beams and the coal hopper. 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.

The structural arrangement of track hopper shall

No columns shall be provided inside the Machinery Hatches.

The vertical and inclined portion of coal hopper, the beams and top of coal tray in the track hopper structure as shown in the tender drawing shall be provided with 50 mm thick guniting (shotcreting). Complete inside surfaces of Wagon tippler shall also be provided with 50mm thick guniting. Details of shotcreting have been given elsewhere in this specification. Shed shall be provided over Wagon tipplers.

Expansion joints shall be provided at a maximum distance of 40m unless otherwise shown in the tender drawing. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. ~~Detailing of expansion joints shall be as per details in the tender drawing~~.

Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m^2.

Water proofing / Damp proofing of under ground portion of track hopper and machinery hatches, Wagon tippler, reclaim hoppers, tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments:

a. Chemical injection grouting for inner faces (details as specified elsewhere).

b. Polymer modified cementitious coating on earth side face as per the following :

(1.) On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

(2.) 50 mm thick P. C. C. (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 mm thick P. C. C. (1 : 2 : 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

Track hopper shall have removable type steel grating cover. The opening size for the grating shall be 400 mm x 400 mm. Machinery hatches shall have removable steel chequered plate cover. Track hopper grating shall be built of min. 150mm x 16mm thick flats in one direction and 100mm x 12mm thick flats in other direction. No painting/galvanization shall be provided in gratings. However, two coats of red oxide primer to be provided immediately after fabrication.

Steel gratings of mesh size 350mm x320 mm(clear) for wagon tippler hopper shall be provided. The grating shall be built of min. 200mm x 32mm thick flats in main direction and min. 100mm x 28mm 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.

Catwalk shall be provided along the track hopper as shown in the tender drawing.

Each machinery hatch shall be provided with a pair of R. C. C. stair for providing access to the base of track hopper / machinery hatch. Both the stairs shall be interconnected at suitable height.

Plinth protection along with drains shall be provided along the Track Hopper and around machinery hatches. However, 5m wide paving shall also be provided around machinery hatches.

The track hopper, wagon tippler are deep underground structures which are subjected to direct load from the loaded wagons / loco due to the rake movement over it, in addition to

load due to coal filled hopper and lateral earth pressure. The railway loads, analysis and design of track hopper, machinery hatches, wagon tippler, transfer point and the portion of tunnel subjected to rail loads shall be as specified in design criteria. Coefficient of dynamic augmentation shall be worked out for a train speed of 30 kms per hour

Earth pressure to be considered for design shall be due to earth pressure at rest (K_o) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (U. D. L) of intensity 2 T / Sq. M. whichever is critical, shall be considered in the design.

A minimum safety factor of 1.2 against uplift of track hopper, machinery hatches, wagon tippler, transfer points (underground or with basement) and tunnels, due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees.

Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

Walkway width and hand railing shall be provided as specified in the tender drawing.

Wherever, slope of tunnel exceeds 10^o, R. C. C. steps shall be provided for the entire width of each walkway.

Track hopper structure shall be analyzed and designed for the worst load combinations. However, it shall be analyzed for the following load combinations also.

a. Load Combination - I

(1.) Hopper full

(2.) Maximum load from Railway Track

(3.) Earth pressure without surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

b. Load Combination - II

(1.) Hopper full

(2.) Maximum load from Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

c. Load Combination - III

(1.) Hopper empty

(2.) No load on Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) No load from steel columns for shed

(5.) Dead load only from paddle feeder supporting structure

(6.) Dead load only from coal tray.

5.07.02 Overhead / Ground Conveyor Galleries and Trestles

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made.

Contractor can also use tubular steel sections for roof truss of conveyor galleries only. The tubular steel section shall be of circular/ rectangular/square shape. The circular steel tube shall conform to IS 1161 and rectangular/square steel sections shall conform to IS 4923. The steel structures using tubular sections shall be designed and fabricated as per IS 806 - "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8:2005.

Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor.

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery (except tripper conveyor) shall be 800 mm and 1100 mm respectively. For tripper conveyor, the width of walkways shall be as per functional requirement. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum

spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10°, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided.

For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc.

Thus coal load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times \frac{1100}{800}$$

It should be noted that for structural design, unit weight of coal shall be assumed as 1100 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 metre. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length) of conveyor gallery of length

not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the arrangements. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa.

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns / ground conveyor portal column base shall be kept 300 mm higher than the existing ground level.

5.07.03 Transfer Houses

The over ground portion of all transfer houses shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding (from lowest working floor level till top) and R. C. C. floors comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both side. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. ~~In all transfer points, contractor shall have option to use Tubular steel sections for bracings only.~~ Vertical bracings shall be provided only on four sides along the periphery. Grade slab with 0.9m height one brick thick wall plastered on both side at periphery shall be provided for all transfer houses.

Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting.

~~Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. Proper gradient shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183)having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations.~~

The roof of Transfer houses shall be provided with per-fabricated insulated metal sandwich panels. Pr-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described in the Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

5.07.04 **Crusher House**

The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors shall be of R. C. C. comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural 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.~~

The roof of Transfer houses shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described elsewhere in the Technical Specification. Adequate slope shall be provided for quick drainage of rain water

~~Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183)having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations.~~

Ring Granulator type Crushers shall be supported on R. C. C. deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This R. C. C. deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework. Detailed specification of vibration isolation system including the unbalanced force (due to ring granulator), frequency and amplitude criteria and other design requirements are appended elsewhere in this specification.

5.07.05 **Stacker-Reclaimer/Reclaimer Foundation**

Stacker-Reclaimer/Reclaimer foundation shall be in R.C.C. and shall be designed as a continuous wall or R.C.C. framed structures (in longitudinal & transverse direction). Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0 m center. The foundation shall be designed for the most critical combination of loads as furnished by the equipment supplier. R.C.C retaining wall on both sides of the S/R foundation shall be provided as shown in the tender drawing.

The portion between the two rails shall be paved in concrete as per specification for grade slab of ground level specified elsewhere. However no metallic hardener finish over R. C. C. slabs is to be provided. Drains shall be provided along the rails for drainage of rain / dust suppression / floor washing water. Drains shall be routed on both sides of the foundation along the rail as shown in Tender Drawing. Drains shall be connected to the network drainage system for finally discharge into coal settling tank. RCC drains shall be provided in Coal stockyard area with precast RCC covers.

5.07.06 Control building, M. C. C. Buildings

or RCC

For steel framed building roof/ floor shall comprise

These shall be steel framed building with R. C. C. roof and floor ~~comprising~~ of RCC slab over profiled metal deck sheets(to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. Cladding shall be of brickwork/concrete blockwork with plastering on both sides. Bidder has also the option to supply and construct pre-engineered buildings Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations.

All air - conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

5.07.07 Pump Houses

These shall be framed structure of structural steel work with permanently colour coated profiled steel sheet roof, grade slab and RCC foundations etc.. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. Brick wall (1m height above FFL) shall be provided all around the periphery of pump houses.

5.07.08 Pent House

These shall be of R. C. C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of steel doors and windows shall be provided for natural lighting and ventilation.

5.07.09 Toilets

Toilet with potable water line facilities shall be provided in each of the following locations:

a. Crusher House (Ground Floor)

b. In all M. C. C./ Control Room building

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 withbevelled edges (Superior sheet glass)	1 No.
	v)	C.P. Brass Towel Rod 600 x 20 mm	1 No.
	vi)	Liquid Soap Container	2 Nos.
	vii)	Washing Tap (CP Brass)	1 No.
	viii)	Overhead Polyethylene water tank (min. 500 litres capacity)	1 No.
	ix)	Suitable provision for installation of water coolers.	
	x)	For control room buildings, pantry with granite top counter& stainless steel sink.	1 No.

5.07.10 Staircases

and mumty of staircase shall be accessible through cage ladder

multistoried

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, MCC/control room (with only ground floor)

All stairs of overground portion of transfer houses & crusher house shall be of steel (minimum 1200mm 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 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.

Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of

openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m2.

Out side stairs to transfer points shall be open type. However sheeting shall be provided at the top.

Stairs of MCC/control room, Wagon tippler and underground TP's shall be of R. C. C. construction. The minimum width of stairs for MCC/Control room, Wagon Tippler, Track hopper, Undeground TP's shall be 1200mm. Maximum rise should not be more than 180 mm and minimum tread with 250 mm. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in wagon tippler/underground TP's.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies.

5.07.11 **Trenches**

All trenches for cables or any other underground facility as detailed out elsewhere shall be of R. C. C. Cable trenches shall be provided with pre - cast R. C. C. covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Trench pre - cast cover weight shall not be more than 65 Kgs. At road crossings & entry locations, trench covers designed for 10 T wheel load at centre shall be provided. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers. For cable trenches outside buildings, top level shall be 200 mm above G. L and sand filling shall be overlaid with 50 thk. PCC.

Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC covers, edges of R. C. C. trenches supporting pre - cast covers, supported edges of pre - cast cover.

5.07.12 **Drainage & Water Supply Works**

5.07.12.01 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 t effluent discharge system (Plant drain network) ~~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 (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry to water / coal slurry to RCC pit (of 2 Cu. M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally into plant drain network.

For TP's in Main plant area, each down comer shall lead the water / coal slurry into the peripheral drains (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry to RCC drain and finally into into plant drain network. ~~nearby road~~.

For wagon tippler complex and track hopper peripheral drains (RCC drains with steel gratings provided around the building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

In case of Control rooms and M. C. C. buildings, Pump houses, etc, water / coal slurry coming from down comers shall discharge into peripheral drains (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry into R.C.C drain, which will lead the discharge finally into trunk drain routed alongside the nearby road/ coal settling pond.drain, which will lead the discharge finally to the coal settling pond./ drain network.

Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings.

Contractor's scope shall also include construction of necessary culverts under the rail lines / roads as per railway / I. R. C. standards and approval of Railway culverts from concern Railway authorities.

5.07.12.02 **Internal and external water supply, drainage etc.:-**

The scope for potable water supply includes all distribution systems, tanks, pipes, fittings etc. as required and as described here or elsewhere in these specifications.

The scope for service water supply and dust control water supply shall be as described elsewhere in these specifications.

For water supply, medium class galvanized mild steel pipes conforming to IS: 1239 shall be used.

The scope for drainage of surface water shall include design, layout and construction of drains for and from buildings and drains required for coal stockyard area, drainage up to main coal slurry settling tank including connection with the tank. Drainage system shall be designed for maximum intensity of rainfall as per area drainage study considering min. 60 % runoff coefficient with no retention time. All buildings (including transfer houses and crusher house) shall be provided with RCC drains of minimum size of 300 mm width and 300 mm depth all around the periphery. All open drains shall have removable steel grating designed for loads as specified under loading clause. Minimum size of main bar of grating (Galvanised to 610 gm/m^2) shall be 12 mm x 3mm and cross bars 6mm. At all entry or road/rail crossing point's RCC box/pipe culvert shall be provided. The opening size of grating shall not be more than 90 mm x 35 mm. All drains as well as pre - cast covers shall be provided with edge protection angles and lifting hooks.

However, drains in coal stockyard area shall have pre cast R. C. C. covers. RCC pre - cast cover weight shall not be more than 65 Kgs. RCC pre-cast covers near entry or at road crossings shall be designed for 10 T wheel load at centre. RCC pre - cast covers shall be designed for central point load of 75 Kgs.

The scope for foul water from toilets shall include layout and laying of sewers up to the main sewer line for sewerage system upto Sewerage Treatment Plant (included in Bidder's scope) together with all fittings and fixtures and inclusive of ancillary works such as connections, manholes and inspection chambers within the building and from the building to the main sewer line.

For rain water down comer and those to be used for conveying water / coal slurry generated from cleaning of walkway/floors, Galvanised MS pipes conforming to IS: 1239 (for 150 mm NB Medium grade pipes) with welded joints shall be used for MCC buildings, penthouse, control rooms and Galvanised steel ERW pipes (273mm OD, 4mm thk) of steel grade Fe330 conforming to IS: 3589 with welded joints shall be used for all TP's, Crusher house, and Conveyor galleries.

Galvanising shall be as per IS: 4736. The minimum mass of zinc coating shall not be less than 360 gms/sq.m. as per IS:6745. The zinc coating shall be smooth and shall be subjected to testing as per IS: 2633, for uniformity of coating. The zinc coating shall be free from all defects as per IS: 2629.

All rain water down comers shall be provided with roof drain heads and complete with shoes bends, junctions, sockets, adapters, brackets and finished with anti corrosive painting over a coat or primer.

For design of building drainage system IS: 1742 shall be followed.

For sanitary / sewerage pipes above ground, sand cast iron pipes conforming to IS : 1729 with leak proof lead joints.

For underground drain pipes, minimum class NP - 2 pipes conforming to IS: 458. At road crossings, concrete pipes of class NP 3 conforming to IS: 458 and at rail crossing R.C.C. box culvert to be provided.

For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch.

5.07.13 **Roof Details**

Roof slab shall be minimum 150 mm above the top surface (crest) of the metal deck sheetthick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom.

900 mm high and minimum 100 mm thick R. C. C. parapet wall shall be provided over roofs. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings.

Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet.

Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster.

Roofs of all M. C. C./control rooms, penthouse, mumty etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as follows:

1) Application of polymerised mastic over the RCC roof to achieve smooth surface as primer coat.
2) Application of high solid content liquid applied urethane based elastomeric water proofing membrane, over the primer coat, to give uniform joint less dry film thickness of minimum 1.5 mm (as per ASTM C 836 and C 898).
3) For efficient disposal of rain water, the run off gradient for the roof shall not be less than 1: 100. This gradient shall be provided by screed concrete M-15 (using 12.5 mm coarse aggregate) and / or cement mortar (1: 4) over the elastomeric water proofing membrane with 25mm thick cement mortar (1:4) topping.
4) Wearing course at top, shall consist of 25 mm thick P. C. C. (M-15) cast in panels of maximum 1.2 x 1.2 m size and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealing compound / elastomeric water proofing membrane. Pathways for handling of materials and movement of personnel shall be provided with 22 mm thick chequered cement concrete tiles as per IS : 13801 for a width of 1000 mm in place of P. C. C.

Roof of transfer points and crusher house shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water.

5.07.14 Floors and Grade level details

The floor slabs shall be minimum 150 mm thick above the top surface (crest) of the metal deck sheetand 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 275 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick R. C. C. of grade

M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the R. C. C. slab.

All buildings (including wagon tippler complex, 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 wagon tippler complex around water tanks near pump house, transfer houses and crusher house shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick metallic hardener finish is not required to be provided in paved area.

Plinth level of all buildings shall be kept at least 500 mm above the finished grade / formation level.

5.07.15 Fencing

Fencing with toe wall and steel gates shall be provided around the transformers. Fencing shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2.4 m above the toe wall. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 12G. All Fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5 m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R. C. C. foundation for the post and stays shall be provided based on prevailing soil conditions. Gates shall be sturdy with locking provisions.

Toe walls of brick masonry shall be provided between fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the formation level with 50 mm thick P. C. C. coping (1: 2. 4) and shall extend minimum 300 mm below the formation level. Toe wall shall be plastered on both sides and painted with two coats of cement paint of approved colour and shade. Toe wall shall be provided with weep holes at suitable spacing.

5.07.16 LOADING

For consideration of loads on structures IS 875 - ‘Code of practice for structural safety of buildings’ shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration). Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design. The structure and equipment shall also be designed for seismic loads as per the “Criteria for Earthquake Resistant Design of Structures and equipment" and the “Criteria for Wind Resistant Design of Structures and equipment". whichever is governing. Wind and seismic forces shall not be considered to act simultaneously. The following minimum live loads shall be adopted for the design of various structures. If actual expected load is more than the specified load, then actual load is to be considered.

a) Roofs — 150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.

	b)	R. C. C. floors	500 Kgs. / Sq. M.
	c)	Stair and balconies	500 Kgs. / Sq. M.
	d)	Toilet rooms	200 Kgs. / Sq. M.
	e)	Chequered plate floors	400 Kgs. / Sq. M.
	f)	Walkways (including walkways in conveyor/cable galleries)	300 Kgs. / Sq. M.
	g)	Conveyor galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @ 125 Kgs. / m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes are shown in Tender Drawing.
	h)	Road Culverts and its allied structures including R. C. C. pipe crossing & road crossing of trenches.	For class 'AA' loading and checked for class A loading as per IRC standard.
	i)	Channels / trenches	In addition to earth pressure and water pressure, etc. additional earth pressure due to surcharge of 2T / Sq. M. shall also be considered for design.
	j)	Covers for trenches / channels	Covers for channels & trenches, shall be designed for a live load of 0.4T Sq. M. and loading as mentioned under clause in trenches, whichever is critical.
	k)	Sumps and tanks and other underground basement type structures	In addition to earth pressure with a surcharge of 2T / Sq. M. (or surcharge due to Railway loading whichever is critical for Railway load bearing structures etc.) and sub - soil water pressure etc. These are also to be designed for the following conditions : i) Water / liquid inside and no earth outside (applicable only to such structures which are liable to be filled up with water or any liquid). ii) Earth with surcharge outside and no water / liquid inside iii) For underground (basement) structures protection against buoyancy during execution and after execution shall be ensured without superimposed loadings with minimum factor of safety of 1.2 against buoyancy.

l) Unit weight of coal shall be taken as 1100 Kgs. / cum. for design purposes.

If the erection load is higher than the specified live loads on any floor or part thereof, then the erection loads are to be considered for the design.

Permissible increase in stresses of materials and bearing pressure of soil due to wind load or seismic load shall be as per relevant I. R. S. and I. S. code.

5.07.17 DESIGN CRITERIA

The loads for all railway load bearing structures and the analysis and the design of these structures (if any) shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as "DFC loading (32.5t axle load)" of Heavy mineral loading as per Indian railway standard. The analysis, design and detailed drawing for tunnel, underground transfer houses, culverts etc. coming directly below the railway track shall be got approved by the contractor from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.

The design of all R. C. C. structures shall be carried out as per 'code of practice for plain and reinforced concrete for general building construction', IS 456.

The steel structures shall be designed and fabricated as per 'code of practice for use of structural steel in general building construction', IS : 800 and other relevant IS Standards. Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. The steel structures using tubular sections shall be designed and fabricated as per IS 806-"code of practice for use of steel tubes in general building construction." And EN 1993-1-8:2005. Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 Mpa& 4.0mm respectively.

The building shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41.

Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.

All gallery supporting trestles shall be so proportioned that the transverse deflection of gallery due to wind / seismic load should not exceed trestle height / 1000 as stipulated in IS 11592. This deflection condition shall be strictly followed. Peak wind speed method shall be considered for checking the transverse deflection.

The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles.

Stresses for all CHP structures shall be checked for the higher of the forces obtained from gust factor method and the peak wind speed method.

The permissible vertical deflection for beams supporting drive machinery shall be restricted to span / 500 and for other beams it shall be within span / 325.

Horizontal bracing system shall be provided at floor levels around the openings.

Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.

For design of liquid retaining structures, IS 3370 (Part - I to IV) (latest) shall be followed. Face of the structure in contact with liquid shall be designed as un - cracked section. For design of R. C. C. pipes for culverts, latest editions of IS 458, IS 783 should be followed.

For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining ground level).

Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory.

Design of masonry walls shall be made as per IS 1905.

Civil task drawing indicating various equipment loading and supporting arrangement and floor loads to be submitted along with the design calculation.

For metal roofing and side cladding, the spacing of purlins/runners shall be such that the deflection of metal sheet used is limited to span/250 under adverse loading condition.

Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcements are required as per design.

It is envisaged that the existing rail lines as shown in GLP will be operational during construction activity of WT, Track hopper, Underground TP's and associated tunnels is taken up. Providing necessary temporary supports such as girders/bridges (railway approved) and all measures to keep the rail lines in safe operating condition during construction of his works, shall be in bidder's scope. Obtaining necessary approvals from the concerned railway authorities including payment of fees, etc. for the same shall be in the scope of the bidder. If during construction of his work, the operating rail tracks get disturbed or damaged, the same shall be restored by the bidder as per the instructions of the engineer, at no extra cost to NTPC.

5.07.18 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 by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

5.07.19 POLYMER MODIFIED CEMENTITIOUS COATING

5.07.19.01 Materials

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size.

5.07.19.02 Mixing

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

5.07.19.03 Properties of Coating

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about $5x10^{-10}$ 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.

5.07.19.04 Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

(a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m^2 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.

5.07.20 SHOTCRETING

5.07.20.01 General Requirements

Generally, shotcreting shall be done in accordance with IS 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

c. Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.

a. Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied.

b. Clear cover to reinforcement mesh shall not be less than 15 mm.

Minimum thickness of shotcreting shall be 50 mm. for abrasion resistant work and 25 mm for ordinary surface protection work.

5.07.20.02 Material

Generally, the materials shall be in accordance with aggregates specification given hereunder.

Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS 383.

Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS 9012.

The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.

5.07.20.03 Application

After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces, reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting.

The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed; not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 3 Kg/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine.

The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All

	rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.
	As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38°C during placing and curing.
5.07.21	**VIBRATION ISOLATION SYSTEM**
	These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal crushers (ring granulators).
5.07.21.01	Supporting Arrangement
	The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an R. C. C. deck supported on steel helical spring units and viscous damper units which in turn shall be supported on girders. The girders shall be an integral part of the crusher house building.
	The part of the structure consisting of the R. C. C. deck, springs and viscous dampers shall hitherto be referred to as “spring supported foundation”. The part of the structure, which is below the spring shall hitherto be called “supporting structure”.
5.07.21.02	The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck which in turn would support the coal crushers. The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for atleast five years.
5.07.21.03	**Scope of Work**
	Scope of work shall include the following:
5.07.21.04	**Engineering**
5.07.21.04.1	Design of the vibration isolation system using steel helical springs and viscous dampers to support an R. C. C. top deck supporting the coal crusher. This includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the coal crusher.
5.07.21.04.2	Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.
5.07.21.04.3	Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.
5.07.21.04.4	Drawings showing embedments and their locations and details on the R. C. C. top deck.
5.07.21.04.5	Drawings showing block outs, recesses etc. on the top deck.
5.07.21.04.6	Design of the supporting structure, including preparation of detailed drawings and bill of materials.
5.07.21.05	**Supply including packing and transportation to site**
5.07.21.05.1	Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

5.07.21.05.2	Frame (s) for pre-stressing of spring elements.
5.07.21.05.3	Suitable hydraulic jacks system including electric pumps, high pressure tubes etc. required for the installation, alignment etc. of the spring units, two extra hydraulic jacks, one hand operated pump and spares for the hydraulic jack system as required.
5.07.21.06	**Erection and Commissioning**
5.07.21.06.1	Complete erection and commissioning of the vibration isolation system including :
5.07.21.06.2	Pre-stressing of spring elements, placing of spring elements in position, checking clearances on the shuttering of the R. C. C. top deck, construction of the supporting structure and the R. C. C. top deck, releasing to pre-stress in spring elements and making final adjustments and alignments after machine installation etc.
5.07.21.06.3	The scope of work shall be deemed to include all activities which may not have been explicitly mentioned but are reasonably implied for the successful completion of the work for which these specifications are intended.
5.07.21.06.4	This part of the specifications is for vibration isolation system. For the construction of the supporting structure for the crusher and the top deck, the relevant parts of the specification should be referred to.
5.07.21.07	**Documentation**
5.07.21.07.1	Submission of detailed design calculation, analysis (static and dynamic) and drawings for Employer's acceptance and approval.
5.07.21.07.2	Furnishing methodology of providing shuttering and its removal as well as concreting of deck slab, installation of springs and dampers and the sequence of operation.
5.07.21.07.3	Furnishing installation and maintenance manual indicating equipment, procedure etc., necessary for installation, maintenance of vibration isolation system.
5.07.21.07.4	Furnishing a check list for confirming the readiness of the civil fronts for the installation of vibration isolation system and equipment required at each stage installation.
5.07.21.07.5	Bill of materials of various elements such as springs, visco-dampers, with their rating, stiffness etc., included in supply.
5.07.21.07.6	Detailed specifications of the vibration isolation system and various items included in the supply and the standard (local or international) to which they conform.
5.07.21.07.7	Proposed erection strategy of the entire system.
5.07.21.08	**Design Requirements for Crusher (Ring Granulator) Foundation** **Dynamic Analysis** Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three - dimensional beam / plate finite elements for the purpose of analysis with the spring idealised with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis. Natural frequencies upto at least 10 % above the operating speed shall be determined and these frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specifications shall be used for his purpose. The amplitudes shall be checked against the design criteria. The dynamic forces from this analysis shall be used for structural design with a suitable fatigue factor.

Isolation Efficiency

The vibration isolation system shall be designed for about 90 % isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly 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 operating speed.

Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

a. Balance quality grade Q 40 as per VDI 2060 - 1966.

b. One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non - drive end of the crusher.

c. Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non - drive end of the crusher.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

1) Operating speed of 750 RPM

a. 150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 - 1966.

b. 300 microns in case of a one hammer broken condition.

c. Amplitudes need not be checked for a three hammer broken condition.

d. Operating speed of 450 RPM

e. 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI -2060-1966.

f. 400 microns in case of a one hammers broken condition.

Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the R. C. C. deck. The amplitudes shall be checked for the most unfavorable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vetor may be considered while superimposing the modes.

5.07.21.09 **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.

5.07.21.10 **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.

5.07.21.11 **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.

5.08.00 **Ash Handling System**

5.08.01 The civil works for Ash handling system shall comprise of bottom ash and fly ash handling systems, ~~which includes Ash water~~ pump house and their related sumps/tanks, Transport Air Compressor house, Switchgear /Control/RIO rooms, foundations for Bottom ash hopper, Buffer hoppers/Collector tanks, bottom ash silos , Silo Utility Building complex with Fly Ash Silos including development of silo area (i.e. paving, fencing/boundary-wall, access roads, office block and watchman cabin), miscellaneous equipment foundations, trenches, pipe racks, transfer points, foundations for conveyor supports (both inside and ~~outside~~ the plant boundary) including bridges/ culverts for road/rail/nallah etc., as required

5.08.01.1 All Buildings for Compressor house, Silo utility building and pump houses shall be designed as per type of building requirement specified elsewhere in the specification. Other buildings like MCC /switchgear rooms, control room etc. will have RCC framed structure with cast-in-situ RCC roof slabs. All buildings shall have brick cladding. Crane girders or mono rails shall be provided as per requirement and the same shall be of structural steel construction.

5.08.02 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

a) Project design intent document giving the basis of design, which shall cover all the design philosophy aspects, parameters, assumptions, references, loading cases, load

	combinations, analysis and design of all buildings, structures, facilities etc. shall be furnished for approval, before commencement of detailed engineering. b) Structural analysis, design calculations and drawings of substructures and super structures for all buildings/structures, facilities like pump houses, compressor houses, sumps / tanks, channels, pipe support structures, culverts/ bridges, pedestals, thrust blocks transformer yards, etc shall be submitted for approval of the owner. c) The design and drawings for the equipments and their supporting structures like bottom ash hopper, buffer hopper/collector tanks, surge tank/settling tank, silos/bins, etc. associated with Ash Handling System, shall be submitted to NTPC for information only. However, the structural design criteria and basis of design as mentioned at (a) above, for these structures also shall be approved by the Owner. d) Top of RCC pedestal of foundation for bottom ash hopper, fly ash silo, HCSD Silo, other columns etc. shall be 300 mm above paving level or surrounding finished ground level (FGL).
5.08.03	Deleted
5.08.04	The Silo utility building complex shall be fenced with chain linked fencing, if placed inside the plant boundary and shall be confined with boundary wall if placed out side plant boundary. Gates shall be provided for rails, truck movement and transformers. The boundary wall shall be of one brick thick of height 2.4 m with a 600 mm high galvanized concentrina at top, such that total height is 3.0 m above formation level. The fencing shall be PVC coated G.I. Chain link of minimum 4 mm thickness (including PVC coating) of mesh size 75mm x 75 mm and of height 2.4 m above toe wall .The toe wall shall be 1 brick thick, minimum 200 mm high above paving/formation level and 300 mm below paving/formation level on 75 mm thick PCC(1:4:8) bedding. Entire area in the silo area complex shall be paved and have a peripheral RCC drain of adequate capacity & slopes covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers of 1.0 m at every 4 m interval .The complex shall be provided with a sump for collection of ash water. In addition to the outer confinement, additional fencing with gates should be provided for all transformers in the complex. A watchman cabin with a minimum area of 5 Sqm shall also be provided in this area.
5.08.05	The foundations & pedestals for conveyor supports including bridges/ culverts for road/rail/nallah etc., shall be provided as per the system requirement. Pipe supports shall be provided dust suppression pipes, dry fly ash(FA) pipes including RCC thrust blocks and any other supports required to complete the system. Over-ground pipes shall be supported on RCC pedestals except for FA pipes which shall be on steel trestles. Unless noted otherwise, the top of concrete pedestals for pipes shall be minimum 500 mm above surrounding ground level and 200mm above paving level in paved areas. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements as per system requirement.
5.08.06	Deleted
5.08.07	If the layout requires the pipes to cross the road on top of ash dyke / road, all pipes shall be laid in hume pipes of suitable dia (NP-3 class) encased in RCC(minimum 200 mm thick) forming a hump on the road. The road shall be modified such that the slope of road along the length, at hump section, shall not be steeper than 1:20.
5.08.08	Single lane maintenance / Inspection road with 1.5m wide shoulders on both sides of the road shall be provided along the route of the ash slurry pipeline from plant boundary wall to the ash dyke along ash pipe lines. The details of road shall be as specified elsewhere for patrol road in the specification. However shoulders shall consist of 150mm thick compacted layer of moorum in place of interlocking blocks specified therein. For stretches of roads in cutting and other stretches wherever necessary, longitudinal rectangular brick side drains with minimum 500 wide and 300 deep shall be provided. Only,the inside faces and top surfaces of the drains shall be plastered with 1:4 (cement : sand mortar) . These drains shall be connected to the nearest available natural drain or low lying area. Adequate cross

	drainage with RCC box culvert or RCC pipe culverts (NP-3) as per topography requirement shall be provided under the access/maintenance road to cater to the surface drainage due to rainfall and other existing drain/nallah . Camber shall be provided on the road. The finished top (crest) of all roads shall be minimum 350 mm above the surrounding finished ground level, however based on the site conditions / low lying areas the height of road top shall be increased. However, in the complex near ash mound it shall be minimum 250 mm above FGL.
5.08.09	Where the pipes are crossing the road through RCC box culverts, the culvert top generally, shall not be not more than 100 mm above the road top and a hump with slope of 1:35 shall be provided on the road. All other road crossings inside the plant area can be either underground or overhead road crossings with necessary headroom clearance. For any boundary wall crossings, pipe shall be laid through casing pipe / RCC culvert. After laying the pipe, the boundary wall shall be restored. For other water body crossings, such as local Nallah / canal, local water bodies, local drains etc. suitable structural arrangement with 800 mm wide walkway shall be provided. Minimum clearance of the bottom of pipeline for all such locations shall be 1.50 M above the High flood level (HFL). Bidder to take all statutory clearance from concerned authorities for crossing his pipe/trestles over road / rail / culverts / nallah etc. at his own cost and initiative, without any commercial implication to the owner. For any other additional works, bidder have to make their own assessment too of the quantity/ number of culverts, existing pipe pedestal crossings, nallah crossings etc., based on their site visit before quoting.
5.08.10	Deleted
5.08.11	Survey inside ~~and outside~~ plant boundary, required for finalization of layout for maintenance road , FA transportation pipe trestles, conveyors up to etc upto silo area in the bidder's scope. The survey shall include the longitudinal section of the entire corridor
5.08.12	All liquid retaining structure shall be designed by working stress method as given in clause 4.5 of IS 3370(Part-2):2009.
5.08.13	The thickness of base slab in liquid retaining/ carrying structures shall be minimum 150mm
5.08.14	The minimum reinforcement in each direction shall not be less than 0.24% of the gross cross-sectional area.
5.08.15	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with clause no.12 of IS:3370(Part 1):2009 and IS:6494.
5.08.16	All pump houses and other substructures shall be checked for stability as per the following guidelines: a) Stability of structure against sliding during construction as well as operating conditions for various combinations of applied characteristic loads. In case where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Factor of safety against sliding shall not be less than 1.4 under most adverse combination of applied characteristic loads. b) Stability of structure as a whole against overturning. It shall be ensured that the resisting moment shall be not less than the F.O.S. times the maximum overturning moment. Factor of safety against overturning shall not be less than 1.2 due to characteristic dead load and shall not be less than 1.4 due to characteristic imposed load. c) Stability of structure against uplift due to the ground water table at finished ground levels during construction and after construction stages. Minimum factor of safety of 1.2 against uplift shall be ensured considering 0.9 times dead weight, empty condition inside and ignoring the superimposed loadings. Inclined wedge action shall be limited to 15 degree with vertical plane. Provision of pressure relief valve / flap valves etc. shall not be permitted to counter the uplift. Also FOS against uplift, to be taken as 1.0 considering the dead weight of structure and soil resting on side

projections, if any, in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

5.08.17 **Architectural Features of Ash Handling System Buildings:**

a. All the buildings shall be fully covered with brick masonry cladding and doors/ windows/ rolling shutters / ventilators.

b. Safety norms shall be followed as applicable. The buildings shall be provided for Pump houses, Switch Gear Room, Control Room etc. as per ash handling system requirements.

External finish shall be of premium acrylic smooth exterior paint with silicone additives over suitable primer of waterproof cement paint.

5.09.00 **Sewerage System**

Bidder shall provide 'De-centralised Sewage Treatment ' units should be as per the design requirements, subjected to minimum combined capacity of 75 Cum/day. De-centralised Treatment units shall be of Sintex (PWTS-STBF or NBF) or Ion-exchange (NGPSTP) make or equivalent. Alternatively, bidder may provide a 'Centralized Sewage Treatment Plant' for complete plant facilities with minimum combined capacity of 75 cum/day and MBBR technology shall be used for centralized sewerage treatment plant.

Complete sewerage system including Sewage Treatment Plant for facilities within the plant is in bidder's scope.

Cement concrete pipes of class NP-3 as per IS:458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, and under roads spun C.I. pipes conforming to IS:1536 of required class shall be used.

RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS:4111.

Sewage pump house shall be provided as per IS:4111.

Sewage treatment plant is to be provided by the Bidder. Bidder shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used.

5.10.00 **Plant Storm Water Drainage System**

Complete storm water drainage system of all areas is in bidder's scope. Total compliance of detailed `Area Drainage Study' report in respect of drains inside plant boundary and its connections to natural drains/river outside the plant boundary area (report attached as Annexure -3) will be in bidder's scope. The drain dimensions shall be based on "Area Drainage Study" report. Any Storm water drain not envisaged in "Area Drainage Study" report, dimensions of such drain shall be designed as per basis given in "Area Drainage Study" report. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M25 for RCC Cast-In-Situ drains and M30 for RCC Pre-cast drains.The drain clear dimensions at any point should not be less than 0.75m (height) x 0.75m (width).

Open RCC rectangular section, unless required otherwise due to functioned requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 150mm or as per design considerations whichever is higher for drains upto depth of 1m from formation level. For depth of drain more than 1m from formation level, the thickness of side walls and bottom slab of RCC drains shall be minimum 200mm or as per design considerations whichever is higher. The drains shall be provided on both sides

of the double lane roads and single lane roads. The drains shall be provided on one side of the patrol roads. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings.

All plinth drains along the periphery of all buildings other than BTG area shall have perforated pre-cast RCC cover of minimum 50mm thickness. The drain in BTG areas shall be covered with cast in situ/ pre-cast RCC covers with minimum 200 mm thickness designed for all crane / vehicular loads. All drains in the BTG area shall also be provided with heavy duty galavnised MS grating with opening of 1m x1m at 7.5m interval.

All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

The invert levels of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main / trunk drains under all conditions.

The invert levels of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level.

5.11.00 Diversion of Existing Drainage And Discharge Of Plant Drainage Into Natural Drainage System

All existing drains crossing the project / site shall be diverted suitably and shall be discharged into a natural drain outside the plant boundary as per the “Area Drainage Study” report. The corridor for drain diversion with maximum width of 10m shall be used for the diversion of drains surrounding the plant area. The section for diversion drain shall be as per “Area Drainage Study” with recommended sectionwith lined sections. The sections as mentioned of Area Drainage Study report, shall be followed for the diversion of drains.

5.12.00 Roads

All roads shall be of rigid pavements unless otherwise specified. The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. Detailed plate load tests to determine the modulus of sub grade reaction “K” shall be carried out as per the procedure outlined in IS: 1888. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.

The road construction including its shoulders, base, sub base and concrete pavement shall be as per IRC standards. IRC: 58 shall be followed for the pavement design and IRC: 15 shall be followed for the construction of the concrete pavement.

The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques. Dry lean concrete shall be minimum M10 grade and concrete pavement slab shall be minimum M35 grade concrete.

The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level.

The sub grade under all roads and its shoulders shall be compacted to achieve 95 per cent or more of Standard Proctor's Density MDD using mechanical means.

Cutting / extending / rerouting / remaking of existing roads including associated works to maintain continuity of road system / network shall also be carried out.

All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed.

Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads.

5.12.01 **Double lane roads:**

The double lane roads shall be (12 metres wide) with 7.5 metres wide concrete pavement and 2.25 metres wide raised shoulders on both sides of the roads.

The raised shoulders (on both sides of the road) shall comprise of 75mm thick inter locking precast designer concrete blocks (M35 grade) at the top, over 20 mm thick sand layer. A 200mm diameter NP3 pipes shall carry the surface water from the road through a PCC drain trench (M20) on both sides of the roads to the drain. The pipes shall run over PCC (M 20) continuous cradle bedding. The pipes shall be laid at 10 metrescentre to centre. A layer of 100 mm (average) thick PCC (M15) shall be laid over the pipes and below the sand layer. All roads shall be provided with edge protection on both sides of the road using pre - cast kerb blocks (450 mm long x 250 mm wide x 500 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.02 **Single lane roads:**

All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads. These shall be single lane roads (5.75 metres wide) with 3.75 metres wide concrete pavement and 1 metres wide shoulders on both sides of the roads. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.03 **Patrol roads:**

All patrol roads along the boundary wall shall be single lane roads with 3.75 metres wide concrete pavement and 1 metres wide shoulders on one side of the road. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar. The road shall slope towards the inner drain. The centre line of ~~the black top of~~ the road shall run at a distance not less than 2625 mm from the centre line of the boundary wall.

5.13.00

Administration Building

Salient Features

The Administration Building shall be a multi–storied RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lifts. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm.

Design Concept

The building shall be designed as moment resisting RCC sway frame in both the orthogonal directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed.

Architectural Features

This building shall be four storeyed (G+3 stories above)and area 4000 sq.m. with RCC Frame structure& Autoclave Aerated Concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. The building shall have a central atrium covered with polycarbonate sheet dome.Top floor of the building shall be dedicated to Full Scope Training Simulator with following requirements:

Simulator Training Room (Air conditioned): 15m x 12m

Battery Room (Ventilated) : 10m x 5m

UPS Room (Air conditioned) : 10m x 5m

Programming Room (Air conditioned) : 6m x 5m

Class Room (Air conditioned) : 6m x 5m

Faculty Room (Air Conditioned) : 6m x 5m

Maintenance Engr Room (Air conditioned) : 5m x 5m

Hermetically sealed double glazing with toughened Glass to be provided for external glazing.

There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, AHU.,MCC Room, First Aid Centre, Library, offices. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms.

2Nos Panoramic Lifts and minimum 2Nos stairs shall be provided.Lift shaft shall be of R.C..C wall.

Covered parking space for 25 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 40 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The Admin building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided. Minimum 70mm Floor finish margin shall be kept for installing metallic raceways.

The rain water down comers shall be provided as per General architectural specification.The rain water down comers shall be suitably concealed by the external wall enclosure.

~~External finish shall be combination of Premium acrylic smooth paint with silicone additives~~

External finish shall be combination of GRC Tile & aluminium composite panel. The GRC Tile of size 250mmx75mmx15mm. (Minimum dimensions) in approved design, size, texture, thickness, pattern and color. The Tile shall confirm to IS :1237-1980. The composition of tiles should be `43' Grade White Portland cement, reinforced with Alkali Resistant Glass Fiber and the pigmentation should be done with exterior grade synthetic inorganic iron oxide pigments. The pigmentation should be homogeneous and in accordance with British Standards BS EN 12878:1999. The other additives should be fine washed graded quartz, super plasticizers and integrated water proofing agents and others. The tiles should be produced with high vibration technology and should have compressive strength equivalent to M-40 Grade@28 days. The top surface of the tiles should be sealed with acrylic lacquer resulting in surface water absorption of tiles, less than 1% and water absorption by 24 hrs immersion method, less than 8%. The tiles should be applied on a rough plaster of cement mortar 1:3 (1 cement: 3 coarse sand) and the fixing of tiles should be done by tile adhesive as per manufacturer's laying instruction

&~~aluminium composite panel~~

5.14.00 Plant Auditorium

Salient Features

Plant Auditorium shall be a RCC framed superstructure. . The building shall have large span Roof structure over the Auditorium Hall. The large span roof structure shall comprise either RCC beams (with camber at bottom surface) and roof slab or structural steel girders/ roof truss (with adequate lateral stability through tie & rafter level bracings / girders in orthogonal direction) and RCC slab over profiled metal deck sheets with purlins.

All the external wall shall be of Autoclaved aerated concrete block wall 250 thick for this fully covered Auditorium with additional internal & external plastering. Handrail for all balconies & staircases shall be made of stainless steel. Floor wall and false ceiling details shall be as per architectural specification.

Architectural Features:

This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1200 sq.m.and shall have seating capacity of 150 persons.

There shall be provisions for Main Entrance Foyer, Lounge, AHU, AC Plant room, MCC room, stage, Green rooms, pantry etc. Separate toilet facilities shall be provided for Ladies & Gents& physically handicapped people.

Plant Auditorium shall be centrally Air Conditioned Building

~~service areas shall be keptand Coloured Aluminium Composite panel~~. False ceiling & wall panelling shall be provided as per Acoustical consideration.

The rainwater down comers shall be provided as per General Arch. Specification and they shall be suitably concealed inside wall enclosure.

External finish shall be combination of GRC Tile & aluminium composite panel.

5.15.00 Main Gate Complex & CISF Building

The Gate Complex shall comprise two(2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates.

Two(2) separate mild steel pedestrian gates minimum 3.0m high and 3.0m width shall be provided at the each end.

The Central Industrial Security Force (CISF) Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with 250mm thick brick wall with provisions for doors, windows & ventilators. The first floor shall also have a viewing gallery. The floor area and architectural details shall be as per the Arch spec. mentioned hereafter in this Specification.

Design Concept:

The CISF building shall be designed as moment resisting sway frame in both orthogonal directions and shall be designed as per IS: 456, IS: 1893 and IS: 13920 (for seismic ductility requirement) and as per design criteria mentioned hereafter in this specification.

Architectural Features

The CISF Building shall be 2-storied building. It shall be of RCC Frame structure& Brick

masonry. The floor area of this building shall be minimum 700 sq m

The Gate Complex and CISF building shall have sufficient no: of guards rooms to regulate movement of men and material and overall security, using latest modern technology like turnstile type/ boom type access control with magnetic cards and close circuit TV sets, computerized time and security office, etc shall be made. For any other gate provided for entry or exit, provision for a suitable small security hut/shed shall be made.

covered

Space provision for CISF personal staff, time office including time machine, reception, lounge, Arms store, Detention Room, Conference room, Toilets and pantry shall be provided as per functional requirement including toilets for Ladies, Gents, Physically handicapped.

The provision for car and scooter parking shall be made. 20 nosCar parking (23 sq.m./car including driveway), Scooter parking- 20 (5 sq.m./Scooter).

In addition, provision for space for open parkingfor5 trucks, &20 cycles shall be provided.

External finishing shall be of Premium acrylic Smooth Paint with silicone additives& Aluminium Composite Panel combination.

Gates Along Boundary Wall:

The gates shall be provided at the entry & exit points of ash bulker movement road, at the entry of railway line, at the entry of material access road to the plant, at the entry of plant from township. No. of gates in Bidder's Scope are as identified in General Layout Plan Drawing No.: 9585-999-POC-F-001.

The gate shall comprise of two mild steel double panelled openable shutter of minimum 7.75 m clear width and minimum height of 3.0m from top of road.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminum ball bearing, castor wheel etc.

All gates shall be given anti-corrosive treatment in three coats.

The structural steel shall confirm to IS: 2062 (latest) and all other relevant IS codes.

Beside the each gate one room of size not less than 3m X 3m shall be provided for security guards. The room shall be made of brick/ RCC and with RCC roof. In addition to the room, one toilet block shall also be provided.

5.16.00 Permanent Store Building

Salient Features:

The scope of work of the Bidder shall be design & construction of all Civil, Structural, and Architectural, Water supply, plumbing & sanitary works of the Permanent Store Building including supply of all materials.

The Permanent Store Building shall comprise the following

a) Heavy Material Storage Hall

b) Light Material storage Hall (With 3 tier Racking System)

c) General Light Material Storage Hall

d) Office Complex.

a) The Heavy Material Storage Hall shall have a Single Bay framed superstructure with RCC/ Structural steel columns and structural steel roof truss. The roof of the Heavy Material Store shall be 40mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. An EOT crane shall be provided with chequered plate walkways at both ends inside the bay of the Heavy Storage Hall. The capacity of the EOT crane shall be 30 T. The clear height up to the bottom of roof trussof the Heavy material storage hall shall be finalized based on equipment/ spare to be handled.

b) The Light Material Storage Hall with 3 tier Rack system shall have a Single Bay framed superstructure with RCC/ structural steel columns and roof truss. The roof of light material Light Material Store shall be 40 mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. The light material store shall be fully covered with external brick wall of 250 mm thickness with provision for doors, windows, rolling shutters as per architectural concept.

c) The General Light Material Store shall be RCC structure with cast-in-situ RCC beams &slabs.The RCC building shall be two storied and all beam-column joints shall be designed and detailed for adequate ductility.

d) The office complex of this store shall be a single storeyed RCC building.

Architectural Features

Total floor area of the Permanent store building shall be 3000sqm.

The minimum clear floor area of Heavy material storage Hall shall be approximately 20% of the total floor area of the Permanent Store with bay width of 15m.Heavy material store shall have column free space for easy movement of materials.The Heavy Material Storage Hall shall be fully covered with external brick wall of 250mm thickness with provisions for doors, windows, rolling shutters as per architectural concept.

The minimum clear floor area of Light Material Storage Hall (with 3 tier storage) shall be approximately 33% of the total floor area of the Permanent Store. The height of the Light Material Storage Hall (with 3 tier rack system) from ground floor slab to bottom of roof truss shall be 10.0m. A part of light material store shall have facility for storing electronic equipment / instruments. This particular area shall be air-conditioned for dust proof environment.

The General Light Material Store shall be two storied building, completely covered with 250mm thick brickwork, doors, windows & rolling shutters. The plan of the building shall be rectangular in shape with minimum floor area of approximately 20% of the total floor area of the Permanent Store.

The area of the office complex building shall be approximately 17% of the total floor area of the Permanent Store, with clear height of 4.0m . The external Wall shall be 250mm thick brick wall with provisions for doors and windows.

The central office shall be provided for management and monitoring the stored materials. Adequate space shall be keptfor loading unloading of materials. Office shall space for Supervisor/In-Charge room, general office cum record-documentation area, toilets, pantry, etc. shall be provided as per requirement.

All the above mentioned four buildings shall be interconnected by means of a covered passage 5.0m wide.

External finish shall be of Premium Acrylic Smooth Paint with Silicone additives

5.17.00 **Facilities to be provided inRailway siding ~~& CHP area~~**

Railway siding work (both inside and outside plant boundary) is not in the scope of bidder. However, the Bidders' scope shall include the following works for inplant Rail yard:
a) Site levelling of the complete inplant Rail yard as per RDSO guidelines/specs (i.e. complete Block 7 as shown in site levelling plan drawing)
b) Patrol road along the boundary wall as shown in General Layout Plan drawing.
c) Approach roads to facilities/buildings in the Bidder's scope.
d) **Trunk drains for overall drainage of Block 7 is in bidders scope. Internal drainage of block 7 is in owner's scope**.
e) Drains from the buildings and facilities in the Bidder's scope to the trunk drains.
f) A tap off near H2 plant (refer General Layout Plan for location) for potable water supply for 50 users and a separate tap off for fire protection to Railway cabin/loco shed.
Construction of bridge/ culverts for facilities/ systems of the bidder crossing the Rail tracks/ yard (above or below the track) inside plant boundary for the following shall be in the scope of the bidder:
1. Crossing of pipe/ cable galleries/conveyors
2. Crossing of drainage/ sewerage system or any other crossing.
Bidder shall ensure that the design of bridges/ culverts or any other structure crossing the Railway tracks are as per Railways/ RDSO guidelines/specifications for DFC 32.5T loads. The scope also includes getting approvals from Railways before start of construction work. Construction of these structures is to be done as per Railways guidelines. Any statutory charges payable to Railways/ RDSO for approval & execution of the above crossings shall be borne by the bidder. Engagement of approved Railway Consultant for the above work by the bidder would be at his own cost.
However, for design of the above crossings above rail track, the following minimum clearance from Rail track shall be maintained:
A. **Horizontal clearance**: A minimum clearance of 3.5m shall be maintained between centre line of the Railway track to face of the crossing structure.
B. **Vertical clearance**: A min vertical clearance of 8.5m shall be maintained between Rail top level and bottom of structure. Bidder has to submit to the owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings. The construction of rail network inside the plant for transportation of coal, fly ash
& POL is in the scope of Owner. The bidder should plan to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding

carryout any modifications as required by the RDSO/Railway authorities at no extra cost to the Owner. Bidder has to submit to the owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings to the owner.

The construction of rail network inside the plant for transportation of coal, fly ash & POL is in the scope of Owner. The bidder has to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding.

5.18.00 TECHNICAL SPECIFICATIONS FOR PRE-CAST BOUNDARY WALL

A pre-cast boundary wall all around the land acquisition line as shown in the General layout Plan for plant area shall be provided. The total height of boundary wall shall be 3600mm above formation level (natural ground level in case formation level is less than natural ground level). Upto height of 3000mm it shall be constructed with precast reinforced cement concrete panels / cast in situ RCC panels and over that for 600mm concertina coil with maximum loop spacing of 125mm shall be provided with Y-shaped MS angle. The RCC precast/cast in situ reinforced concrete columns shall be provided at spacing not more than 2500mm centre to centre.

The RCC precast/cast in situ reinforced concrete columns and footing shall be minimum 1500mm below finished formation level with suitable foundation designed for horizontal and vertical loads. The precast reinforced concrete panels/ cast in situ RCC panels shall be at least 600m below formation level. The RCC precast concrete columns/ cast in situ RCC panels of minimum size 300mmX350mm shall be provided with two grooves of minimum size 115mmX50mm, so as to receive Precast Concrete RCC panels spanning from column to column with minimum width of 600mm and minimum thickness of 100mm as filler wall. The grade of concrete for all precast/cast in situ work shall be of M30 grade conforming to IS 456.

However, foundation / footing shall not rest in filled up strata.

The boundary wall shall be designed as per relevant IS codes and as per standard practices. The same shall be submitted to Owner for approval at the time of detailed engineering, The architecture of boundary wall shall be finalized in consultation with Owner. The precast/ cast in situ reinforced cement concrete coping with minimum projections of 150mm on each side shall be provided at the top of the precast reinforced cement concrete panels / cast in situ RCC panels with suitable provision for MS angle Post for concertina throughout the boundary wall. Opening for gates/drains and for other crossing shall be suitably provided as per the requirement.

All exposed concrete surfaces of all precast members/ cast in situ RCC members have high quality shuttering finish with tolerance of +/- 5mm. Plinth protection of 150mm thickness PCC (M20) shall be provided on both side of boundary wall extending upto 300mm from centre line of boundary wall. High quality shuttering to be approved by Owner.

5.19.00 FIRE WATER PUMP HOUSE, FIRE WATER BOOSTER PUMP HOUSE& FOAM SYSTEM

Salient Features:

The scope of the Bidder shall be design and construction of Civil, Structural, Architectural, Water Supply, Plumbing and Sanitary Works of Fire Water Pump House, Fire Water Booster Pump House and foam system including supply of all materials.

The fire water Pump House shall be single storeyed and single bay RCC superstructure. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans.

The Fire Water Booster Pump House shall be a single storeyed RCC superstructure. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans

Steel shed with roof covering and sides open shall be provided for foam system including associated civil works for foam bladder tank foundations, grade slab, pipe pedestals etc.

5.20.00 Not used

5.21.00 **Fuel Oil Handling system**

The civil works are to be provided for following fuel oil handling system areas as mentioned below:

a. Fuel Oil pressurizing pump house.

b. Foundation and dyke wall and all associated works for LDOtanks.

c. Pedestals and foundations to support the interconnecting piping between LDO tanks to the pressurizing pumps as well as piping from tanker unloading area to the Unloading pump house and further on to the LDO tank and also pedestals from railway unloading trench to unloading pump house

d. Tanker unloading platform.

e. Fuel Oil Unloading Pump House.

f. Oil water separator pit.

Fuel Oil Pressurising Pump House

Salient Features:

This building shall be a single storeyed framed superstructure with RCC columns, structural steel roof truss(with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise 40 thick RCC slab supported on profiled metal deck sheet. Waterproofing on Roof slab shall be done as per architectural specifications. The building shall be completely covered with 230mm thick brick wall with provisions for Doors, windows, rolling shutters. the building shall have separate enclosures for the control room and the switchgear room. All rainwater down comers shall be concealed with brick wall. The minimum floor area of this building shall be as per the equipment layout plan of the bidder/ EPC contractor.

Design Concept:

The grade of concrete shall be M 25 for all columns, beams, footing and slabs. The building shall be designed as per IS: 456, IS 800, IS 1893, IS 13920 (for ductility detailing)

The Fuel Oil Storage Tank foundations shall be either RCC raft or RCC Ring Beam system with compacted infill. The RCC raft /RCC ring beam shall be supported on virgin soil or pile foundation depending on the load bearing capacity of the soil. The tank bottom base plate shall

be supported on flexible compacted fill comprising 75mm thk Bitumen aggregate mix on top and compacted sand/ soil fill below, compacted in layers of 200mm to minimum 85% relative density as per IS:2720. The bitumen-aggregate mix shall consist of compact crushed stone, screenings, fine gravel, clean coarse sand(river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. In the GA & detailing of foundation RCC ring wall/ beam it should be ensured that no bearing stress from tank superstructure is transmitted to the concrete surface.The top of flexible compact fill and top of RCC Circular wall shall be atleast 325mm above the surrounding ground surface for effective drainage.

The finished tank grade(Top surface of flexible compact fill) shall be crowned from its outer periphery to its centre at a slope of 1 in 100.

The Tank foundations shall be inside a RCC dyke wall enclosure. The entire area outside the tank foundations and within the surrounding RCC dyke walls shall be paved with concrete. The thickness of concrete paving shall be minimum 100mm.The single layer reinforcement in paving slab shall be min 10 Tor@200c/c. The area paving RCC slab shall be supported on 230mm thick Rubble soling with the internal voids filled with coarse sand. The height of the RCC dyke wall shall be evaluated based on the depth of Oil spillage for full oil volume of one storage Tank in addition to a free board of 300mm. Structural steel cross over ladder shall be provided (min 2 numbers) for each RCC wall dyke enclosure. Operating platforms wherever required as per functional requirement shall be provided.

The road tanker unloading platform shall be heavy duty RCC paving minimum 250 thk RCC slab resting on elevated compacted ground surface. A minimum slope of 1:250 shall be provided (in one direction) for the slab for Oil-Water Surface run-off to the peripheral drain. Expansion joints shall be provided in chess board fashion. RCC ramp shall be provided for approach of truck

The rail tanker unloading platform shall be based on the railway guidelines and statutory rules.

Fuel Oil Unloading Pump house shall be a covered building with RCC columns and Structural Steel Roof truss. 250mm thick external brick wall shall be provided with provisions for fire proof door, windows & rolling shutters. The basement RCC slab & RCC wall shall be designed as for uplift and external surcharge load as per the design criteria specified elsewhere. All fuel oil pump foundations shall be designed for both static & dynamic loading. The roof slab shall comprise 40th RCC slab over profiled permanent metal deck sheet (min 0.80mm thick) connected through shear anchor studs specified elsewhere in this specification.

The Oil-Water Separator RCC structure (pit) shall be designed as an underground structure. The sizing of the separator shall be based on the total surface run-off from the Fuel Oil Handling area and Hydraulic design for the oil separation. Surcharge load and ground water table up to ground surface shall be considered in addition to other functional loads for structural design of RCC wall for the separator pit.

Drainage trenches with proper bed slopes towards the oil-water separator pit shall be provided around the tank foundation. The entire area outside tank foundation shall have slope towards the drain trenches

Foundation for trestles and pedestal foundations, for supporting the pipes, shall be provided wherever required, at appropriate spacings. At pipe bends, necessary thrust resisting arrangement shall be provided.

The entire fuel Oil Handing area shall be fenced all round with minimum 1.50m high metal fencing with provision for gates at key locations.

Seismic design shall be carried out for the Fuel Oil Storage Tank foundation, Fuel Oil Unloading Pump House & the Oil water separator.

Architectural Features of Fuel Oil Handling Buildings:

Spaces for Pump Rooms, MCC Rooms, Control Rooms, etc shall be provided as per functional requirement. One Toilet shall be provided.

External finishing shall be of Premium Acrylic Smooth Paint with Silicone additives over suitable primer of water proof cement.

5.22.00 **O&M Workshop Building**

The O&M Workshop Building shall be a two bay fully covered building. The two bays shall comprise of workshop bay and office complex bay. The minimum span of workshop bay shall be 25m with RCC columns, structural steel roof truss and 40mm thick RCC roof slab supported on troughed permanently colour coated metal decking sheet and purlins. Roof water proofing shall be applied on roof slab as per details specified elsewhere in this specification. The Gantry girder for the EOT crane in the workshop building shall be structural steel plate girder supported on RCC corbels at column locations. The gantry girder shall be complete with chequered plate walkways (at both sides) and the cage ladder.

column free

The adjacent Office Complex bay shall have RCC superstructure. The minimum bay width shall be 6.50m.

Architectural Features:

The building shall be fully covered with brick wall masonry. provision of doors, windows & Rolling shutters shall be included based on architectural detailed drawing to be developed by the bidder. The rainwater down comers shall be provided at every column location and they shall be suitably connected to the building surface drain.

The minimum operating floor area for the workshop bay shall be 25mX110m out of which 450 sqm shall be earmarked for maintenance exclusively

The minimum head room of workshop bay shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level.

The office complex shall be 6.50mX110m in plan area. The office complex shall be made 2 storied for adequate space for operating personnel, MCC room, stores, Laboratories, Toilets, Conference room & Tool room. The floor to floor/ roof clear height shall be 4.50m.

5.23.00 Canteen

Salient Features: The Canteen Building shall be a RCC framed superstructure with large span roof system. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1100 sq.m.

The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc.

External finish shall be of Premium Acrylic Smooth Paint with Silicone additives.

There shall be separate service road and entrance for supply of cooking materials and garbage disposal.

5.24.00 Fire Station Building

Salient Features: The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

The number of fire tenders/ equipements shall be provided as given in Part-A Subsection-IIA-11

It shall be of RCC Frame structure& Brick masonry. The building shall be provided with area 600 sq m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. The number of fire tenders shall be provided as per CISF norms. One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dinning Hall, Rest Rooms, Stores, First Aid Room shall be provided as applicable.

External finish shall be Premium Acrylic Smooth Paint with Silicone additives

5.25.00 Dozer Shed

Architectural Feature

This building shall be prefabricated steel framed structure with brick wall up to window sill height & prefabricated insulated double skin metal sheeting cladding above it. Roof of the building shall be prefabricated insulated double skin metal sheeting on steel roof truss.The building shall provide for Dozer shed space, Workshop space, Office Rooms, Stores, Toilet & Pantry as per functional requirement. Minimum size of the dozer shed shall be 500 Sq.m.

Metal side cladding shall be composed of different colour shades to match with the other buildings. External finish for brick walls shall be of Premium Acrylic Smooth Paint with Silicone additives.

5.26.00 Area Paving in Main Plant Block

RCC paving of minimum 150 mm thick with M25 grade concrete, over an under bed 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 under bed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thick for normal duty paving and 400mm compacted thick for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil followed by 75 mm thick 1:4:8 PCC (1 part cement, 4 parts sand and 8 parts stone aggregate) with 40 mm nominal size aggregate. For normal duty paving, reinforcement of the RCC paving shall consist of minimum 8mm dia bars @ 200 mm c / c in both directions at the centre of the slab. For heavy duty paving/ passage, reinforcement of the RCC paving shall consist of minimum 10mm dia bars @ 200 mm c / c in both directions at the centre of the slab.

Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification.

Entire main plant area from chimney (edge of the storm water drain behind chimney) to transformer yard as enclosed within the peripheral roads of the main plant block and Air Cooled Condenser (ACC) Block enclosed between the peripheral roads shall be provided with paving.

All ground floor slab at 0.0m level inside the Main Plant building shall be provided with 50mm thick metallic hardener topping.

Passages shall be provided inside the Main plant block & ACC block connecting to the outer periphery road to have access to the various facilities/buildings. These 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 also be provided for the areas in the equipment lay down area in TG hall, complete Mill bunker building and handling areas for PA/FD/ID fans with 50 mm thick metallic hardener topping.

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 outside Main Plant building, Mill Bunker Building, Boiler area, ESP area, Transformer yard area & ACC block where no heavy traffic movement is envisaged shall be provided with interlocking concrete block paving with RCC 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/ non-expansive soil.All other areas inside the Main plant block & ACC block shall be provided with normal duty paving without metallic hardener topping.

Para Deleted

~~In FGD area and in Denox system area, an area of 5 m width all around the buildings & facilities shall be provided with normal duty paving. This paving shall be beyond the extent of plinth protection. Further, heavy duty paving shall be provided for passages connecting the outer periphery road to have access to the various facilities/buildings.~~

~~In CPU area, 2.5 m wide normal duty paving around periphery of all sumps and underground tanks without metallic hardener shall be provided.~~

Open

Suitable drains shall be provided to dispose off storm water drain. 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 & Boiler to sump of suitable size.

Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from Main Power block to sewage pump house.

5.26.01 GROUND FLOOR SLAB OF BUILDINGS

In ground building including Main Plant Building, the ground floor slab shall consist of 150mm thick RCC M25 grade base slab over an under-bed a specified below. The under-bed of ground floor slab shall consist of 75 mm thick 1:4:8 PCC on stone soling of 200 mm compacted thick with 63mm and down aggregate with interstices filled with well graded selected sand/ moorum / non-expansive soil on compacted and dressed sub-grade. Reinforcement for the slab shall consist of minimum 8mm dia bars @200 mm c/c at top & bottom of the slab in both directions. However, at passages, unloading & maintenance bays, stone soling of minimum 400mm thick and minimum 10 mm dia bars @ 200 mm c/c at top and bottom in both directions shall be provided. Further, top surface of ground floor slabs shall be finished with 50mm thick metallic hardener topping.

5.27.00 Hydrogen Generation Plant Building

Salient Features

The Hydrogen Generation Plant Building shall be a RCC framed superstructure and its size shall be as per system requirement. This building falls under hazardous building category. The entire building campus shall be properly fenced to prevent unauthorised ingress or egress.

Architectural Features

This building shall be RCC Frame structure with brick masonry wall with provision for doors, windows, rolling shutters and exhaust fans.

Toilets & pantry, etc. shall be provided as per requirement. External finish shall be premium acrylic smooth exterior paint with silicon additives.

5.28.00 Conveyer's gallery

Architectural Features:

This shall be Steel frame structure with Single skin Metal Panel on sides and top roofing.

There shall be M.S. louvered windows and fixed glazing of polycarbonate sheets.

5.29.00 Not Used

5.30.00 Cooling Tower Switch Gear Room/Control Room

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.31.00 Switchyard Control Room Building

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.32.00 Water & Effluent Treatment Plant building

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.33.00 Owner's Construction Office:

Pre-engineered One number of Owners Construction office is in Bidders Scope. This building should be single storyed. The building should be as per the tender drawing no. 9585-001-POC-A-002

The floor area for owner's construction office shall be 1400 Sqm

Pre-engineered building shall be of structural steel construction with metal roofing of approved profile and wall cladding should be of silica fibre board.

Pre-engineered building shall be complete in all respect as per tender drawing 9585-001-POC-A-002

5.34.00 **Not Used**

5.35.00 FQA LAB BUILDING

FQA Lab building shall be double storied R.C.C building with area 400 sq.m. It shall consists of spaces Offices & for Laboratories for Mechanical, Electrical, Civil& C&I. Toilets for Gents, ladies and handicap shall be provided as per NBC guidelines.

5.36.00 **CHP Workshop cum Office Building**

This shall be RCC framed structure having two storeys in office area and single storey (double height) in workshop area. Total floor area of the building shall be 900 Sq.m (700 Sq.m. Office area and 200 Sq.m. Workshop).

5.37.00 **SAFETY CENTRE**

~~Safety Centre Building shall be a R.C.C Building with area 200 sq. m. IT shall consist of Classrooms for 50 students, stores, office, staff room and toilets for ladies gents and physically handicapped persons.~~

~~The external finish shall be of Acrylic Smooth Exterior Paint with silicone additives.~~

This building shall be provided complete in all respect as per tender drawing 9585-001-POC-A-005.

5.38.00 **IT BUILDING**

IT Building shall be a R.C.C Building double storeyed with area 1200 sq.m. It shall be a completely air-conditioned building. IT Building shall be located inside plant boundary. It shall have spaces / facilities for IT Server Room, IT Communication Room, IT Operator Room, OFC Cables & Terminators FMS Room, Telephone Exchange Room, Battery Room, UPS Room, IT Store Room, IT Kiosk, three numbers cabin, conference hall, Testing and Repair Room, Executive hall, HOD Room with attached toilet, Secretariat for HOD, AHU, M.C.C Room, Pantry Toilets for Gents, Ladies and physically handicapped persons as per NBC norms, Staircases as per NBC norms. Space for installing V-SAT Antennae on Ground shall be provided. Minimum Floor to floor height shall be 4.50m. Minimum 70 mm floor finish margin shall be provided for laying metallic raceways.

IT building shall be a GRIHA rated building with minimum three star rating. The external finish shall be combination of Acrylic Smooth Exterior Paint with silicone additives and Aluminum Composite panel.

Clause No 5.39.00 to 5.39.10 Deleted

~~5.39.00 **Railway siding system (including in-plant yard) for Transportation of Coal, Lime, POL, Gypsum and fly ash.**~~

~~5.39.01 **Review of Existing Railway Siding System**~~

~~Patratu TPS (325MW) is located bear Patratu town, Ramgarhdist, Jharkhand state. The plant is connected to Indian Railway network through approx. 3 km siding between plant and Patratu Railway station of Tori-Barkakhana section of East Central Railway. Coal for the project is being received through Indian Railway network.~~

	Review of existing railway siding system, to meet transportation of coal to plant for existing plant (325MW) and Proposed expansion in two stages (3x800MW+2x800MW) for railway siding system to meet transportation of coal and lime-stone to plant and evacuation of fly ash and gypsum from plant through Indian Railway system.
5.39.02	**SYSTEM DESIGN**
5.39.02.01	Consolidated traffic study for coal and non-coal movement to the project in view of receipt of coal through BOY, BOX, BOXNHA, BOY25, BOXNLW, BOXNHL, BOXN25, BOX32.5 BOXN and BOBR wagons (in line with RDSO G33, Rev 1 latest guidelines).
5.39.02.02	Study of additional facilities required inside plant & siding including the drainage system and other facilities crossing the proposed railway tracks. Study the requirement of locomotives for marshalling /shunting of rakes inside plant, recommended numbers and rating of locomotives required.
5.39.02.03	Optimize the track work and use of facilities to achieve designed unloading rate on a long term basis. Suggest procedures to deal with exigencies during shunting/marshalling. Study is also required for examining the possibility of engine on load scheme by elaborating the benefits of the scheme
5.39.02.04	The system should have capability to release the coal rakes received at the project within the free permissible time.
5.39.02.05	Arrangements for Communication system in consultation with Indian Railways, Provision of FOIS (Freight Operation Information System) or any other suitable system by Railways to know the rake status for Power station at any time.
5.39.02.06	Study the manpower requirement/ railway staff requirement to be posted at the cost of Patratu STPP and facilities to be provided. Study should elaborate the advantages and disadvantages on liberalized siding rules and possibility of handling of heavy haul rakes (longer rakes)
5.39.02.07	Assessment of electrical (OHE) and S & T requirement
5.39.02.08	Assessment of locos and workshop facilities, if any, as required.
5.39.02.09	Preparation of detailed system of working and station working rules. The report should contain the traffic study/turnaround time etc. The study may also indicate number of crossing stations/block sections/facilities required for Rail movement. Construction sequencing shall be planned without affecting the Coal transportation and movement of rail for existing 325 MW plant in operation.
5.39.03	Survey
5.39.03.01	Field reconnaissance for existing track from take-off point to plant entry and proposed augmentation. Final location survey forpicking up field data for preparation of index plans and longitudinal sections for detailing for bridges and culverts, opening and level crossings, over bridges and fly-overs/ FOB/ RURB/ RORB/viaduct for the rail track. Determination of road crossings, grade or grade separators, road diversions etc.
5.39.03.02	Establish correlation between Railway bench mark and Plant bench mark levels. The Coordinates of Railway siding also to be furnished as per the coordinates system adopted inplant General Layout Plan (GLP).

5.39.03.03	The assessment of additional land requirement (if any) by giving details such as private, govt., forest etc. and preparation of land requirement, if reqd, on Khasara map (including schedules & cadastral map) for land acquisition purpose for which may crop up during preparation of Engineering scale plan/ construction stage of the Railway siding. Identification of structures required demolition and its cost estimate and compensation (if any) to be paid.
5.39.03.04	Identification of culverts for drain, pipe crossings, manned and unmanned level crossings, bridges, FOB etc. No manned level crossing are to be provided on the MGR/ Railway siding. ROB/ RUB is to be provided for all road crossings. Crossing of Indian Railway tracks, if required, is to be done through a grade separator only (Rail over Rail Bridge).
5.39.03.05	NTPC Land boundary pillars for the Railway siding corridor (minimum size 200mmx200mmx900mm long @ 100m c/c)) are to be provided after construction and commissioning of the Railway siding system. The location of the pillars is to be marked in the as built drawings
5.39.04	**Detailed Project Report**
5.39.04.01	Finalization and submission of Detailed Project Report based on final survey results, system design, manpower requirement etc. The detailed project report shall identify the cost estimates inclusive of the work executed through Railways as deposit works and the time schedule for execution of the works.
5.39.05	DETAILED ENGINEERING This covers in general the electrified and non-electrified track, bridges, ROB/RUB/RORB/Fly overs, viaduct, culverts, buildings, control rooms, workshops etc. this will include the following:-
5.39.05.01	Preparation and submission of detailed technical specifications with applicable tender drawings, BOQ, cost estimates with unit rates for each and every item of civil work in tender schedules covering all types of bridge/ culverts, banks and cutting, drainage works, cable trenches, goomties, control rooms, station buildings, track and permanent way including rails, sleepers, points and crossings, fish plates and other track fittings etc.
5.39.05.02	Preparation of schedule of quantities of materials for which advance procurement action will be necessary viz. Cement, sleepers, track fittings, rails, ballast, etc. schedule of quantities for works to be done through deposit work shall also be prepared and submitted separately.
5.39.05.03	Preparation and submission of detailed design and construction drawings for each and every item of civil work as elaborated above including geo-technical investigation as required for detailed design of bridges, culverts, embankments etc. All clarifications/ queries on the construction drawings during execution including any revision thereof shall be furnished.
5.39.05.04	Preparation of detailed design and drawings (and obtaining the approval of Railways and other concerned authorities) for the following. a. P-way b. Yard Modifications c. Formation of bank and cuttings d. Bridges, culverts, crossovers etc. e. ROBs /RUBs, buildings, workshops etc. f. All civil and structural works pertaining to OHE and S&T works.
5.39.05.05	For design of bridges following shall be considered:

	i) The rainfall storm and catchment area considered for determining flood discharge and criteria for fixing waterway. The expected afflux and its impact on nearby habitated areas should also be examined. ii) Calculations of scour depth for foundation design of bridges. iii) Upstream, downstream and bed protection design and criteria, if any.
5.39.06	SIGNALLING AND TELECOMMUNICATIONS AND OHE WORKS
5.39.06.01	Preparation of detailed system design for signaling, telecommunication works and OHE works (if required). All portions pertaining to Railway Siding shall be got approved by Railways.
5.39.06.02	Preparation and issue of technical specifications, BOQ, tender drawings (signal plans, panel diagrams and selection tables for signaling works and as required for telecommunication and OHE works) and cost estimates.
5.39.06.03	Study of existing S&T system of the serving station and suggest modifications required (if any) in the existing system.
5.39.06.04	Drawings for layout of control room/ cabins including equipment & cable layout and foundations related to the installation of S&T works.
5.39.06.04	Submission of list of spares, tools & plants and maintenance schedule.
5.39.06.05	Possibility of use of solid state signaling with LED may be studied.
5.39.06.06	In addition to tele-communication provision of wireless communication between control room, loco drivers, Railway station, operation I/c is also required to be explored.
5.39.07	**Construction of Railway siding system**
5.39.07.01	Construction of the Railway siding system is to be undertaken as per Railways guidelines through railway approved agencies/ Consultants.
5.39.07.02	Construction of the complete railway siding system including in-plant rail yard for stage I (3x800MW) (including siding from serving station to plant, Augmentation of serving station, in plant rail yard as per Railways requirement, ROB, RUB, bridges/culverts, viaduct all necessary drainage arrangements for entire railway siding etc) including S&T (Signaling & Telecommunication), OHE (Overhead Electrification) and other associated works such as panel buildings, TXR building etc as per railways requirement. Construction of Rail track for stage II facilities is not envisaged in this contract. Adequate provisions for Stage II facilities shall be provided in the facilities being provided by the bidder. Bidder is required to provide necessary take-off with isolation arrangement for Stage II tracks (Turnout with point machine plus minimum one rail length track plus isolation including OHE and S&T) for connection at a later stage without affecting traffic of stage I units. Further, the panel buildings/ S&T system should be for the S&T requirement of Stage I & Stage II. Scope also includes up gradation of the existing railway siding system, including the serving station(s) as per the requirement of Indian Railways.
5.39.07.03	Facilities of in-motion Weigh Bridge (150T capacity) for weighment of all inward & outward rakes is in the scope of bidder. In-motion weigh bridge to be provided as per RDSO specifications. Two weigh bridges (complete with building etc) each for weighment of loaded

and empty rakes are to be provided. The location of the weigh bridge is to be finalized by the bidder.

5.39.07.04 Level crossing, whether manned or unmanned, is not permitted in the siding from serving station to plant boundary. All road crossings outside plant boundary is to be provided with Grade separator i.e., Road over bridge (ROB) or Road under bridge (RUB).

Existing level crossing is to be changed with Grade separator i.e., Road over bridge (ROB) or Road under bridge (RUB).

For road crossings inside plant boundary, ROB/ RUB is to be provided at the locations indicated in the General Layout plan issued to the bidders.

Suitable drainage arrangements with connections upto final disposal points are to be provided for the RUB to avoid water-logging.

5.39.07.05 Loco shed with all facilities required for carrying out maintenance as per half yearly schedule as per Railway standards. However, the following minimum facilities are to be provided:

a. Loco shed 30m x 20m with inspection pit of 25 long & EOT crane 40T x 10T-20m span.

b. Double storied office building of 480 sqm area for office/ store for loco maintenance.

c. Fuelling facility/ station – 45KL capacity including filling arrangement.

d. Washing apron 25m long is to be constructed as per Railway standards with oil separator pit.

5.39.07.06 Construction sequencing shall be planned without affecting the Coal transportation and movement of rail for existing 325 MW plant in operation.

5.39.08 **Facilitation in Land Acquisition /Procurement /Leasing of land**

5.39.08.01 Facilitation in Land Acquisition /Procurement /Leasing of land as necessary, for and on behalf of PVUNL, for construction of the siding. Bidder shall coordinate with local revenue/ State Govt authorities, local panchayat and PVUNL project authorities for acquisition/ leasing of land, as necessary (for construction of siding) on 'willing buyer willing seller' basis. Bidder shall be responsible for finalising the land plans/ land schedules, identification of rightful ownership documents/ details, negotiating the land cost/ compensation in association with revenue/ state Authorities/ PVUNL, submitting applications in required format, disbursement of land costs/ compensation to rightful owners in form as advised/ agreed by State Authorities (including facilitating opening of bank accounts of beneficiaries), completion of documentation for transfer titles/ mutation of land to PVUNL, taking physical possession of land including vacation of land oustees and any other activity required for taking possession of land & final handover of land to PVUNL. The payment of land cost cost/ compensation as per advice & agreement with land owners/ State Authorities shall be paid by PVUNL.

5.39.09 General requirements

5.39.09.01 Preparation and submission of Detailed Project Report incorporating above details to obtain approval from NTPC/Railways. The report should include recommendation clearly based on a techno -economic study bringing out tangible/intangible benefit to NTPC on the subject.

5.39.09.02 Complete co-ordination and liaison with Railway, state/central govt. including the approval of the scheme from Railways and other agencies as required.

5.39.09.03 Co-ordination with NH/state authorities/ for ROB, RUB and obtaining their clearances.

5.39.09.04 Traffic study, Staffing study for O&M, railway staff to be deployed at the proposed TPS at NTPC cost.

5.39.09.05 All coordination with any other agency whose facilities have interface with the Railway siding/coal transportation system.

5.39.09.06 The consultant appointed for the DPR, Detailed Engineering and Construction should have valid enlistment with the concerned Railways till the validity of this contract.

5.39.09.07 The geo technical investigations shall be done strictly as per RDSO/ Railway's guidelines. Copies of RDSO/railway's guidelines (latest revisions) required for the detailed Engg work shall be made available to NTPC

5.39.09.08 The Bidder shall be shall be responsible to provide all necessary services, documents and technical information consisting of and relating to detailed engineering, procurement, construction, and supervision and commissioning activities of the PROJECT as applicable in accordance with Standard Engineering Practice/Railways/RDSO guidelines. Documents shall also include all relevant RDSO drawings required for inspection and execution of the job. 5 (five) sets of all relevant RDSO drawings OHE, S&T manuals and IRPWM etc shall be handed over to NTPC at the commissioning of the Project.

5.39.09.09 The Bidder would be required to supervise the operations for a period of 12 months beyond the successful commissioning of the system for stabilizing of the system and resolution of problems/ issues arising out of the same including coordination with concerned agency/ Railways.

5.39.10 **Deliverables**

The Bidder shall submit, the following documents to NTPC:

i. Eight (8) copies of draft Detailed Project Report including drawings and land plan assessment.
ii. Twelve copies (12) of Final Detailed Project Report & ESP along with the drawings.
iii. Construction drawings & As-built drawings: 8 sets
iv. 5 sets of reproducible copy (CD ROM) of Draft DPR, final Detailed Project Report along with the drawings, As built drawings.

Note: The above requirement is exclusive of submissions required for clearance/approvals from railways/ State/ Central Govt agencies/ NH.

5.40.00 AIR COOLED CONDENSER SUPPORTING STRUCTURE

The bidder shall have the option to design the air cooled condenser (ACC) supporting structure either with structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions or **with RCC pylon structure.** The general arrangement & details of structural steel columns, beams, bracings or **RCC structure** shall be as per the bidders ACC structure design and detailed engineering scheme.

In case of steel supporting structure, the bottom level of base plates of columns shall be 1.20 M below the finished floor level of ground floor of Main Power House. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 350 mm above the top of the paving RCC slab.

In case Bidder adopts RCC pylon for Air cooled condenser structures, casting of the same shall be done using slipform shuttering. For construction of RCC pylons, bidder should engage an agency who has experience in construction of RCC shell-like structures like chimney/ silo/ pylon using slipform equipment.

Design Concept:

ACC supporting super-structure shall be designed by the Bidder based on working stress method for (i) structural steel as per IS 800 & for (ii) RCC pylons as per IS 4998 & CICIND model code and RCC foundations as per IS : 456.

5.41.00 Balance Buildings

For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements. 5.42.00 Flue Gas De-sulphurization System attached as Annexure-1

6.00.00 DESIGN CRITERIA

6.01.01 **General**

The design criteria given herein is applicable for all structures and buildings including Main Plant buildings, Control building, office/service building, Mill and Bunker building, Coal Conveyor Galleries/Trestles, Transfer Points, Track hopper, Tunnel, Pent house, Stacker-reclaimer supporting structure, Crusher house, Chimney, Cooling towers, Fuel Oil Handling Plant, Light Diesel Oil Handling System, Pump Houses, Compressor house, D.G. Set building, switch gear and other miscellaneous buildings, Culverts, Bridges, Water retaining/carrying structures, Boiler/ESP supporting structures, Switchyard structures, Ash Silos, Roads, Drains, Sewers, Cables and pipe trestles, all ash handling facilities and various other works included in the scope of the bidder. facilities of FGD system

6.01.02 Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static, friction and dynamic), earth pressure & surcharge loads, Hydrostatic & Hydrodynamic loads, wind loads, seismic loads and temperature loads. In addition, Erection loads, loads and forces developed due to differential settlement shall also be considered.

6.01.03 i) All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction. Columns having depth of 400mm & less shall have bracing in single plane and at the centerline of column. For columns having depth of 500mm & above, the longitudinal bracings shall comprise a pair of members (spaced) with spacing equal to the column depth. Only where axial bracing to one vertical plane is to be waived due to functional requirement, columns in that vertical plane may be allowed to undergo biaxial bending. Beam column joints shall be detailed as per seismic resistant joint with adequate ductility.

All 2-legged structural steel trestles shall be completely braced in the vertical plane. All 4-legged structural steel trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway.

If the superstructure is RCC structure, the superstructure shall be moment resisting sway frame in both orthogonal direction and all the members shall be designed for biaxial bending. Design of RCC structures shall be done as per IS 456 Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. Design of liquid retaining structures shall be done as per IS 3370

ii) The Main Plant building, Bunker building, transfer towers, conveyor galleries and trestles, crusher house, boiler, ESP Control Building, ESP supporting structures, including inlet and exhaust duct support structures, Compressor House, Pipe cable Gallery shall have structural steel framed super structure.

iii) All other buildings may have either RCC or structural steel framework.

iv) All buildings having RCC framing shall have masonry cladding of minimum one masonry unit thickness (not less than 225 mm.) on exterior face.

v) Cladding detail for specific building shall be provided by the bidder as per final recommendation for type of buildings furnished to the bidder.

6.02.00 **Loading**

6.02.01 **Dead loads**

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

6.02.02 **Imposed loads**

Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.

For consideration of imposed loads on structures, IS:875 (Part-2) "Code of practice for design loads (other than earthquake) for buildings and structures" shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.

Sl.No.	Location	Imposed Loads (T/Sq.m.)
A)	Turbine Building	
i)	Ground floor (general)	2.50
ii)	Ground floor (heavy equipment storage area)	5.00
iii)	Mezzanine floor	1.00
iv)	Operating floor	
	a) Rotor Removal area	5.00
	b) Equipment lay-down area	3.50
	c) Other areas (corridors, etc.)	1.50
v)	Gratings, chequered floors, walkways, platforms, stairs, etc.,	0.50
vi)	Roof (Where no equipment is located)	0.15
vii)	Roof (where equipment are	

located) 0.50

B)	Deaerator and Heater Bay		
	i)	H.P/L.P. heater floor	1.00
	ii)	Deaerator floor 1.00	
	iii)	Cable gallery (In addition to this, actual cable load shall be considered)	0.50
	iv)	MCC, switchgear and Control building floors	1.00
	v)	Roof (Where no equipment are located)	0.15
		(Where equipment are located)	0.5
	vi)	A.H.U Room, Battery Room, Air Washer Room	1.0
C)	Mill and Bunker Bay		
	i)	Ground floor	2.5
	ii)	Feeder floor	0.50
	iii)	Tripper floor	0.50
	iv)	Roof	0.15 (Where no equipment are located) 0.50 (Where equipment are located) 0.075 (For Inaccessible roof)
D)	Pump Houses		
	Operating floor		1.50
E)	Maintenance bay (CWPH & RWPH)		3.0

F) Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc.

In addition to earth pressure and ground water pressure, the surcharge load of 2T/sq.m. shall also be considered for design of all underground structures.

G) Road Culverts/Bridges and its allied structures including RCC Pipe Crossings and Road Crossing of Trenches.

Design for class 'AA' loading (wheeled and tracked both) and checked for class 'A' loading as per IRC Standard.

H) Covers for Channels/trenches — 0.40 (General) or central point load of 75 kg whichever is higher

		As per IRC Standard (at road crossings for vehicular traffic)
I)	Railway Supporting Structures, Rail Culverts	As per Railway 'Bridge Rules'
J)	Boiler/ ESP Support Structures	
	i. Operating Floors	1.00
	ii. Separator Floor	1.00
	iii. Elevator Machine Room	1.00
	iv. Maintenance Platforms	1.00
	v. Equipment Laydown Loads	As per Equipment supplier or 1.00 whichever is more.
	vi. Lift Structure	As per Equipment supplier with 100% impact factor
K)	Conveyor Galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @125Kg/m(minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes
L)	General (Unless Specified Otherwise)	
	i) Stairs, Landings and Balconies	0.50
	ii) Toilets	0.20
	iii) Chequered plates, grating floors, etc.,	0.50
	iv) RCC floors (General)	0.50
	v) a) Flat Roofs (where no equipment are located)	0.15
	b) Flat Roofs (where equipment are located)	0.50
	c) Inaccessible roof	0.075
	vi) Inclined Roofs	As per IS : 875 (Part-II)
	vii) Dust load on roof	Equivalent to 0.30 M of ash deposit
	viii) Walkways (General)	0.50

	ix)	Walkways of conveyor galleries, DM & PT	0.30
	x)	Floor of control room of switchyard control building	1.00
	xi)	Cable and pipe trestles addition, friction loads	0.40 for walkway and in as applicable

Notes:

a) If erection load is higher than the specified imposed loads on any floor or part thereof, then the erection loads are to be considered for the design.

b) Additional load for cable, piping/ducting, shall be considered as applicable. For any other structures, the loads specified for those structures elsewhere in the specification shall be followed.

c) Load of 1 Tonne/Sq.m shall be considered on floors of all Switchgear room, Cable Vaults including those for Switchgear and Cables, supply of which is not included in Bidder's scope. Load for cable trays shall be 50kg/m/tray – for 300mm wide tray and 75kg/m/tray – for 600mm wide.

d) Load for Indoor (Dry Type) transformer, to be supplied by others and to be installed in LT Switchgear room (Bidder's scope), shall be 8.0 Tonne.

6.02.03 **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.

6.02.04 **Crane load**

For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously.

6.02.05 **Seismic load**

For design of all structures, the site specific seismic spectrum as attached in Annexure-(e) shall be followed.

6.02.06 **Wind load**

For design of all structures, the wind loads shall be taken as per the site specific wind data specified in Annexure–(d) of this specification.

6.02.07 **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.

6.02.08 **Differential settlement Loads**

Structures shall be designed considering an additional load on account of differential settlement of 1 in 1000 between any two adjacent columns, subject to a maximum differential settlement of 8 mm in case of foundations resting on soils & 4mm in case of foundations resting on rock/ pile.
These differential settlement loads shall be taken into consideration for design of footings & structures of Main Power House & Control Tower, Boiler & Mill Bunker, ESP supporting structure & ESP Control room only. Further, adjacent columns interconnected with vertical bracings are preferably be provided with combined footing. In such cases, where rigid combined foundations are provided below braced columns, differential settlement between those columns needs not be considered. Moreover, when rigid raft is provided, the differential settlement amongst the columns supported on the rigid raft need not be considered. However, the differential settlement between the raft and the adjacent column footing of the same structure are to be considered. In the structural analysis for calculating loads due to differential settlement, following approach may be considered: All the alternate columns in structure shall be applied downward differential settlement as described above and analyzed at a time. The resultant forces/ reactions shall be considered with reversible effects along with other load cases for design of structures and footings.

6.02.09	**Additional Loads** Following Minimum additional Loads shall be considered in the design of Steam generator structures, Mill & bunker buildings, Coal handling Transfer points and Trestlesand ESP structure. (a) Cantilever Loads of not less than 2000 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the ESP, for Cable trays and Walkways. (b) Cantilever Loads of not less than 500 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the Steam Generator, for Cable trays and Walkways. (c) Cantilever Loads of not less than 2000 Kg / M at a distance of 2500 mm from the external face of the Mill & Bunker Building columns, CHP transfer point columns/ VGTU columns & conveyor gallery trestles (on one side) for Cable trays and Walkways. (d) Dry Fly Ash Piping Loads. (e) Ash Water Piping Loads. (f) Supply Air and Instrument Air Piping. (g) Service Water Piping (h) Loads associated with Coal Handling Plant equipment
6.2.10	**Air Cooled Condenser support structures shall be designed for:** i) Live/Imposed loads. ii) Dead load iii) Static and dynamic loads of piping, movable equipment and maintenance parts. iv) Loads from cable trays and walkways supported on columns. v) Seismic and wind loads as specified elsewhere in the specifications. vi) Temperature variation as specified elsewhere in the specification. vii) The loads listed above indicate the minimum requirements.
6.03.00	**Civil Design Concepts**
6.03.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.,
6.03.02	The different load combinations shall be taken as per IS: 875 (Part-5) and other relevant IS Codes. a) Wind and seismic forces shall not be considered to act simultaneously. b) For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall be considered. c) 'Lifted load' of crane shall not be considered during seismic condition. d) In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.

e) In case two cranes are provided and tandem operation is envisaged then the crane wheel loads shall be taken as both the cranes fully loaded to capacity and travelling side by side althrough the Main Power House building length.

f) Permissible stresses for different load combinations shall be taken as per relevant IS and IRS codes.

g) For the design of pipe/cable supporting structure, the soil weight shall be considered as backfilled up to grade level for the condition of pipe running full/cables in position.

h) Frictional forces between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

i) Paving in crane corridor shall be designed for the maximum load due to movement of crane.

j) In TG bay at crane rail level, chequered plate walkway with handrails shall be provided for entire column sectional depth for full length of the building. Walkway width clearance from the face of the column to the edge of the crane shall be as specified elsewhere in the specification.

k) For checking against uplift / tension case, 90% of Dead Loads with no Imposed Loads shall be considered along with other Loads.

l) The Structures shall be Designed for most unfavorable Combination of Dead Loads, Imposed Loads, Equipment Loads, Piping / Cables / Ducts Loads, Wind / Seismic Loads, Temperature Loads, Ash Loads, and other applicable Loads without exceeding the Permissible Stresses

m) In all Loading Combinations, the Loads that have reduction effect on design condition shall not be taken into account in the Combination concerned.

n) Where Wind is the main Load acting on the Structure, no increase in Stresses is to be considered for Design of Structures and Foundation Bolts.

o) In all Load Combinations, differential settlement loads (with reversible effects) are to be considered.

6.03.03 Design of steel structures shall be done by the Working stress method. Design shall be as per provisions of IS:800:1984 and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (part I to III) shall be followed.

6.03.04 Shop Connections will be all welded type and field connections will shall be bolted. Field permanent bolts wherever provided will be high tensile bolts of property class 8.8(min) as per 1367 for all major connections. However, nominal connections in the field like purlins, stairs, wall beams will be done by means of M.S. black bolts of grade 4.6 conforming to IS-1367. The bolted joints will be designed for friction grip or bearing type. For friction grip type connections, bolts will be tightened to develop the required pretension during their installation.

For bolted 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.

6.03.05 For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force, casual over burden and impact factor, etc. Thus coal load per unit length of each moving conveyor shall be

$$\frac{1.6 \times (\text{rated capacity of conveyor system})}{\text{Conveyor speed}} \times \frac{1100}{800}$$

6.03.06 a) Conveyor gallery structure and trestles shall be designed considering both conveyors operating simultaneously

b) Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25 m.

c) All structures close to railway line shall have clearances conforming to Railway norms.

6.03.07 Horizontal Deflection criteria

The maximum Horizontal Deflection for various structures shall not exceed and be limited to the following:

Sl. No.	Description	Maximum value of
1.	For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)
2.	For Main Power House (Turbine Bldg), ESP Control Building, Compressor House, Service Building, Workshop Building, Balance of Plant Buildings and all other buildings envisaged in this specification	Height /325
3.	Vertical Metal Sheeting in Cladding	Span/250

However, the maximum deflection of Grating / Chequered Plate Shall be limited to 6mm.

Note: Stresses under wind load condition for all structures shall be checked for the higher of forces obtained from Gust Factor Method and Peak Wind Speed Method.

For deflection check on TP's/ Trestles Wind Load by Peak Wind Speed Method along with load due to Belt Tension and Dead Loads shall be considered.

6.03.08 a) Dispersion of load in any direction through soil shall be as per IS: 8009 (relevant part).

b) Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.

6.03.09 a) Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.

b) The allowable deflection for beams directly supporting drive machinery and equipmentshall be restricted to span/500 unless specified otherwise in this specification.

c) The deflection for manually operated cranes & monorail supporting beams shall not exceed span/500.

For electric overhead cranes :

1) upto 50 t capacity : span/750

2) over 50 t capacity : span/1000

d) The vertical deflection of beams supporting LP Heater, HP Heater and Deaerator shall be limited to Span/500.

e) The vertical deflection of metal deck sheet for floor shall be limited to span/250.

f) Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / chequered plates shall be span/250. However, the maximum vertical deflection of Grating/ Chequered plate shall be limited to 6 mm.

6.03.10 Transverse coal pressure on Bunker/Silo/Hopper walls shall be calculated as per IS: 9178. The Coal Bunker/Silo/Hopper shall be designed for the following conditions

i) The Bunker/Silo/Hopper is full up to its full capacity with top surface nearly horizontal.

ii) The Bunker/Silo/Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.

6.03.11 Design criteria for ash silo

1. The pressure due to ash filling on the side wall and the bottom portion of ash bins/silos shall be taken as the maximum of (a) static pressure determined in accordance with the Jansen's formula multiplied by an impact factor of 1.4 and (b) pressure determined as per Walker's formula for static as well as dynamic conditions. The silo shall be designed for the following conditions:

   (a) The silo is full up to its full height / capacity

   (b) The silo is partially empty with top surface of ash, at an angle of repose less than 30 degrees.

2. The following loads are to be considered for design.

   a) Density of bottom ash to be considered for volume calculation shall be 650 kg./cu.m.

   b) Density of bottom ash to be considered for load calculation shall be 1600 kg/cu.m.

   c) Density of fly ash to be considered for volume calculation shall be 750 kg/cu.m.

   d) Density of fly ash to be considered for load calculation shall be 1600 kg./cu.m.

   e) Density of dry fly ash, to be considered for the design of supporting structures for dry fly ash conveying pipes, shall be taken as 1000 kg/cum. The pipe shall be considered full with dry fly ash.

3. Other requirements are as follows:

   a) Independent supporting structure shall be provided for each silo.

   b) The joint between the wall and roof of the silo shall be properly sealed by welding or by any other approved means.

   c) Operating platform covering total plan areawise in silo structure made of grating shall be provided below the hopper outlet.

   d) The bracing system shall be provided in such a way that the trucks and closed tankers can have a clear passage to approach the underside of the silos for unloading dry ash from the silos.

4. Trestles supporting ash pipes shall be so proportioned that the transverse deflection of trestles due to wind/seismic load shall not exceed trestle height/325.

5. The corrosion allowance for design of Silo, Buffer Hopper, Bottom ash hopper, tanks etc. shall be considered as per IS:9178 considering structure exposed to atmosphere. The corrosion allowance shall be provided in addition to the requirement of minimum thickness of steel plate as per IS:9178.

6.03.12 Coal Bunker (inside Mill Bunker Building) shall be of MS while the hopper shall be of MS with stainless steel (grade SS 304) lining. The minimum thickness of MS plate and SS lining in hopper portion shall be as specified in the design concept of Mill Bunker Building in the previous chapter. Pre-formed flexible open ended bellow strap of neoprene is to be provided between top of bunker and bottom of tripper floor to avoid coal dust leakage / escape. The bellow strap shall be of minimum 200 mm wide under un-stretched condition and shall be of minimum 2mm thick.

The hopper angle with the horizontal plane be as specified in the previous chapter.

6.03.13 The live storage capacity of each coal bunker shall be greater of the following:

a) Total 10 hours coal requirement of the boiler for BMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere.

b) Total 10 hours coal requirement of the boiler for BMCR duty with design coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere.

c) Total 10 hours coal requirement of the boiler for TMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required to be in service for this duty condition as specified elsewhere.

6.03.14 For all capacity (volume) calculation and structural design (load calculation) unit weight of coal shall be assumed as 800 Kg/cu.m. and 1100 Kg/cu.m respectively.

6.03.15 Design pressure on coal bunker/hopper walls shall take into account all possible flow regimes (core flow, mass flow, etc.), and different aeration regimes (radial, diametrical, radial and core, impulsive, etc).

6.03.16 a) The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.

b) For design and construction of steel-concrete composite members, IS: 11384 shall be followed.

c) For reinforcement detailing, IS: 5525 and SP: 34 shall be followed.

d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.

6.03.17 Not Used

6.03.18 Not Used

6.03.19 Not Used

6.03.20 Not Used

6.03.21 **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. 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 Mill shall be as specified in Chapter-5 of 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 ISO 1940 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 ISO 10816.

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 5% to 10% 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.

For TG Raft/ Pilecap, minimum percentage of reinforcement at top and bottom faces of foundation shall be same as that stipulated for beam as per IS:456.

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. 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 ISO 10816, 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.
6.03.22	If RCC floor/roof is assumed to act as diaphragm, transmitting lateral loads to braced bays, it shall be provided with shear connectors. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.
6.03.23	All roads shall be rigid pavements specified elsewhere in this specification. The design traffic load shall be a minimum 4 million cumulative standard axle. The design of concrete pavement shall be carried out as per IRC-58.
6.03.24	a) No cable/pipe trench is envisaged in the plant area. However, if required, pipe/cable trench can be provided inside the buildings and inside switchyard or some other localised areas. b) All pipes and cable shall generally be routed above ground. c) A minimum clearance (clear headroom) of 8 m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 600mm width with hand-rails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc.Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, upto the pipe/cable racks/trestles. d) Within AB bay in Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.
6.03.25	Appendix –(1)"Area Drainage Study for Patratu Super Thermal Power Project" is enclosed. The plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, intensity of rainfall, etc., The storm water drainage shall cater to storm water run off resulting from one hour rainfall intensity, with a return period of 50 years. These values shall be based on the "Detailed Area Drainage Study" subject to minimum rainfall intensity of 75mm/hr. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. RC box culverts shall be provided at rail, road or other crossings.
6.03.26	Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec. Manual on sewerage and sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose.
6.03.27	**NOT USED**
6.03.28	Foundations for all tanks shall be designed for as per IS: 803.

6.03.29 Footings shall be so proportioned to as to minimise the differential settlement.

6.03.30 **Boiler/ ESP support structures shall be designed for:**

a. Dead load

b. Live/Imposed loads

c. Static and dynamic loads of piping, movable equipment and maintenance parts.

d. Loads from cable trays and walkways supported on columns.

e. Ash water piping supported on the outermost row of boiler columns.

f. All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of electrodes (whichever is more) using a bulk density of not less than 1350 kg/cu.m. for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case).

g. Ash load at bottom ash hopper and pent house of the boiler shall be as mentioned in the mechanical chapter of the specifications.

h. Seismic and wind loads as specified elsewhere in the specifications.

i. Temperature Loads.

j. Temperature variations under ESP operating condition.

k. The loads listed above indicate the minimum requirements.

l. For the Design of ESP Supporting Structures for Seismic, Ash Load in Hoppers filled upto to the top of the Hoppers or bottom of the electrode (whichever is higher) shall be considered as permanent Loads along with other applicable Loads.

m. Following Ash density shall be considered for the Design :

Sl.No.	Description	Density (Kg/Cu. M.)
a)	Bottom Ash for volume calculations	650
b)	Bottom Ash for Load calculations	1600
c)	Fly Ash for volume calculations (For Boiler)	750
d)	Fly Ash for volume calculations (For ESP)	650
e)	Fly Ash for Load calculations	1350
f)	Dry Fly Ash for dry fly ash Pipeline supporting Structures (Pipe to be considered full)	1000

6.03.31 Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 °C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0 m. The exact levels shall, however, be decided during detailed engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

6.03.32 The bracings in boiler structure shall be provided such that under no circumstance

normal/convenient access to all points in the boiler is blocked or obstructed.

6.03.33 In design of boiler/ ESP support structures, dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

6.03.34 Design Criteria for foundations and some other facilities/areas are covered separately in this specification.

6.03.35 Plinth level of all buildings shall be kept at least 500 mm above the finished grade/formation level.

Finished floor level of boiler area paving shall be kept about 200 mm lower than the finished floor level of Main Plant buildings.

6.03.36 Joints/Connections in steel structures:

Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:816, IS:9595, IS:1367, and IS:9178 and as per following requirements.

a) Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b) Size of fillet weld for flange to web connection for built up section shall be as follows:

i) For box section weld size shall be designed for full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.

ii) For built up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated, in drawings) whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be double fillet.

iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.

c) Shear connections shall be designed for 60% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d) Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

e) All butt welds shall be full penetration butt welds.

f) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Engineer.

g) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.

h) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

6.03.37 Pipe Pedestals, pipe supports and other structures for Ash handling system:

a) The design of Pipe Pedestal and pipe supports shall be carried out considering Dead

load, live load & seismic load / wind load. In addition to above, longitudinal forces equal to product of Co - efficient of friction (between contact surface of pipe and pedestal) with the load coming on each pedestal shall also be considered for the design of pedestal. In bends, suitable thrust block shall be provided to withstand the thrusts transferred from the pipelines.

b) All RCC pipes carrying water under gravity shall be designed for earth pressure, water and surcharge. Minimum grade of pipe shall be of NP - 2 class or heavier required as per design / specification.

c) The design and construction of RCC structures shall be carried out as per IS: 456. In general, limit state theory shall be followed for the design of RCC structures, however, working stress method shall be adopted for the design, wherever specifically mentioned in this specification.

d) Two layers of reinforcement (on inner and outer face) shall be provided for RCC wall sections having thickness 150mm and above.

6.03.38 **Design Criteria of RCC Floors**

a) For Main Power House, Mill Bunker Building, ESP Control Building, Transfer Houses of CHP, and other structural steel framed buildings:

These buildings being steel framed structure, all RCC floors shall comprise RCC slab supported on troughed, profiled metal deck sheet of minimum thickness 0.80mm (to be used as permanent shuttering). The RCC slab shall be minimum 150mm thick above the top surface (crest) of the metal deck sheet. The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self weight of green concrete and additional construction load of 100 kg/m2.

The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification.

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design).

(b) For Administrative Building, Service Building, CISF building & other RCC buildings.

These buildings being complete RCC framed structures, conventional RCC slabs of minimum thickness 125mm shall be provided. The RCC slabs shall be monolithic with RCC beams and RCC columns

6.03.39 **Design Criteria of RCC roofs:**

a) For Main Power House, Compressor House, ESP Control Building:

The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design.

b) For Mill Bunker Building, Transfer Houses.

Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at

bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification.

c) Other RCC Buildings.

Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

6.03.40 Design Criteria for Foundation

The founding depth / cut off level of piles shall be decided based on functional requirement.

Where structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving except for Main power House Building columns, Boiler Structure, Bunker Building Columns, TP & Trestle Columns, ESP Control Building Columns for which the requirement of levels for bottom of base plates is specified elsewhere in this specification. Further the gusset plate and foundation bolts are to be encased in concrete up to the top of the paving level. For outdoor structural steel columns, about 300 mm height of steel columns above the top of paving level shall be provided with at least 125 mm thick encasement with minimum reinforcement to prevent corrosion of the steel columns from surface water

a)OPEN Foundations

For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification.

For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.

The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456.

No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC of grade M7.5.

b)PILE Foundations

Minimum centre to centre spacing of the piles shall be 3 times the diameter of pile. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other.

Minimum penetration of piles into Pilecap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face of pile cap shall be same as that stipulated for beam as per IS:456.

Detailed requirement of pile foundation have been presented in the foundation chapter specified hereafter in this specification.

6.03.41 **Coal Handling Plant structures**

a) The loads for all railway load bearing structures e. g. track hopper including machinery hatches, tunnel, culverts and under ground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions

of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up .to the date of opening of bids. However, the axle load for analysis and design shall be considered as "DFC loading 32.5 MT axle load". Coal heap of 1.2m height shall be considered above hopper top for design of coal tray, hopper and supporting elements of track hopper. The analysis, design and detailed drawing for the structure coming below the railway track shall be got approved by the Bidder from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.

b) The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles.

c) Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory

d) Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm.

e) The buildings shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41.

f) Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.

g) Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.

h) For design of R. C. C. pipes for culverts, latest editions of IS : 458, IS : 783 should be followed.

i) Design of masonry walls shall be made as per IS : 1905.

j) Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcement is required as per design.

6.04.00 **Corrosion Protection**

6.04.01 **GENERAL**

(a) All equipments, pipes, etc. shall be painted as per the requirements specified in the relevant section of the specification.

(b) All Steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of Corrosivity category C3 (durability High) as per ISO 12944.

Painting system for steel surfaces embedded in Concrete is given separately.

(c) All Paints shall be of high build constitution.

(d) All Painting shall be done as per approved Painting scheme of the Vendors / Manufacturers, which shall be submitted by the Bidder and as approved by the Employer.

(e) All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3 ■

(e) All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance of 1.5 mm shall be kept in thickness(over the design thickness) of structural steel members for Patratu Super Thermal Power Station.

6.04.02 **PAINTING OF STEEL SURFACES EMBEDDED IN CONCRETE:**

a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.

6.04.03 PAINTING OF STEEL SURFACES (OTHER THAN THOSE EMBEDDED IN CONCRETE)

d) All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00

e) Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

f) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

Notes:

1. For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.
2. The most frequent problem associated when top coating Primer is bubbling/pinholing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.
3. In case topcoating of zinc silicate with epoxy/polyurethane coatings, is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust. However, if white rust forms then clean the surface with high pressure water, dry and apply the subsequent coats as required.
4. Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.

6.04.04 **TOUCH-UP PAINTING ON DAMAGED AREAS**

a) For Coatings damaged up to metal surface

Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer.

Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within maximum seven (7) days of application of touch up Primer.

b) For Coatings damaged upto Intermediate Coatings (i.e. where Primer Coat is intact).

Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat.

Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.

6.04.05 Painting of welded areas / painting of areas exposed after removal of temporary supports / touch-up painting on damaged areas structures, where inter-connection, welding / modification etc. Has been carried out by the bidder.

a) Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.

b) Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.

6.04.06 Dry film thickness of each coat shall be checked and measured as per the procedure specified in paint application standard no. 2 by SSPC: The Society for Protective Coating. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of technical specification.

6.04.07 Coating for Mild Steel parts in contact with Water.

a) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 Gms / Sq. M. for galvanised Structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.

b) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

6.04.08 Gratings

All gratings shall be blast cleaned to Sa 2 ½ finish as per ISO 8501-1and shall be hot dip galvanized at the rate of 610 Gms / Sq. M.

6.04.09 Hand Railings and Ladders

All Mild steel handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. as per IS: 4736. However, Stainless steel handrails shall be provided as specified in General Architectural Specification clause 9.0.0.

6.04.10 Sea Worthiness

All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti corrosive Paint before shipment to take care of sea worthiness.

6.04.11 All structural steel members in switchyard (excluding fencing and gate) shall be hot dip galvanised as specified elsewhere.

6.04.12 **For reinforced concrete work.**

i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.

This shall require use of dense and durable concrete, control of water cement ratio,

increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.,

Bidder shall furnish the details of corrosion protection measures.

7.00.00 **FOUNDATION SYSTEM AND GEOTECHNICAL DATA** For detail Refer Annexure-1

7.01.00 **Soil Data**

Owner has carried out preliminary geotechnical investigation at the project site. Available borelogs along with laboratory test results, are enclosed at Annexure-A for Bidder's reference. The preliminary geotechnical investigation report for these areas will be made available for the Bidder's study at the Owner's office, if required.
Onus of correct assessment/ interpretation and understanding of the existing subsoil condition / data is on the Bidder. Bidder may refer topographical survey drawing for variation in existing ground level.

7.01.01 Contractor shall carryout detailed soil investigation for the facilities under this package. The scheme for geotechnical investigation shall be as given at **Clause 7.08.00** and shall be approved by Owner before execution. Geotechnical investigation work shall be got executed by the contractor through the agencies as mentioned in Clause No. 7.07.00. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.01.02 The Bidder should note that nothing extra whatsoever on account of variation between soil/rock data collected by Owner and that found by the contractor during detailed geotechnical investigation by him or during execution of works, shall be payable.

7.01.03 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil. If the encountered sub-strata is black cotton soil, the same shall be either replaced upto the full depth or black cotton soil shall be stabilized by suitable treatment.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Annexure-I. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 Open Foundations

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

S. No 381 Amendment-4: All foundation in a particular Structure (between expansion joint) shall rest on particular stratum based on geotechnical consideration. Where large variation in stratum is observed , the foudnation level to be maintained by building up with PCC from the intended stratum.

c) ~~It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum~~.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC up to designed foundation level.

e) No foundation shall rest in black cotton soil.

f) Contractor shall carry out detailed geotechnical investigation, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	8	10
2.0m below NGL	-	12	15
3.0m below NGL	15	18	20
In case of founding stratum is rock			
0.5m embedment into very dense sand with SPT 'N' Value more than 60 and upto 100	30	35	35
1.0m embedment into disintegrated rock, into very dense sand with SPT 'N' Value more than 100	40.0	40.0	40.0
2.0m embedment into disintegrated rock	50.0	50.0	50.0

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

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

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	25 mm

Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

7.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250

The piles shall be socketed 5m (minimum) into rock.

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 4 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (xi) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.03.00 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 Excavation, Filling and Dewatering

7.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

7.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.03 Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non cohesive soils. In any case, black cotton soil shall not be used in back filling without providing cushion of 1m of non expansive cohesive soil / moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.4m moorum shall be provided.

Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.

7.04.04 Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

7.04.05 CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

7.04.06 The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

7.05.00 EXCAVATION IN ROCK

Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02

a) Contractor shall engage an agency expert in blasting such as, CMPDIL, CMRI, Dept. of Mining of Govt. Institutions, etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives

as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

For deep excavation in CHP area, sheet piling / contiguous pile / secant pile / diaphragm walls may be required depending upon the proximity to the existing facilities. The excavation design & scheme shall be developed by a specialized agency.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT), Electrical Resistivity Test (ERT), Cross Hole Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum.Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No**. 7.08.00.** Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Clause No. 7.08.00. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined

Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, recommendation along with slope stability calculation for deep excavation, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. CengrsGeotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00

Geotechnical Investigation Scheme

a) Boreholes (Minimum)

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main power house, Turbo-Generator (TG)	35 to 45 m along the rows of main power house columns. Minimum 2 boreholes under each TG	Depth of boreholes shall be 25m to 30m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.
2	Main Plant structures (Boiler, ESP, Chimney, Mills, Fans etc)	Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 4 boreholes under Chimney, Minimum 2 boreholes under each ESP Control Room, TPs, Fans and Duct Support.	Depth of boreholes shall be 25m to 30m.	
3	Service Building	Minimum 2 no of boreholes	20 to 25 m	
4	CPU Building	Minimum 2 no of boreholes	15 to 20m	
5	Flue Gas Ducting and Absorber Area (FGD)	Minimum 15 boreholes	20 to 25m	
6	Ash Handling Structures	Minimum 8 boreholes	20 to 25 m	
7	Corridors for Ash pipe routes, Ash Water recirculation pipe routes & Make-up water pipeline	1 borehole @ 500 m c/c along the identified corridor and one ERT shall be conducted near each borehole in Ash Water recirculation pipeline corridor	8-10 m	
8	Crossings along the pipeline corridor like road, river, nallah/	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of	20 to 30m	

	canal, Approach bridge	boreholes inside the river/ nallah of width more than 10.0m		
9	Air cooled condenser (ACC)	Minimum 10 no of boreholes	25 to 30 m	
10	Switchyard	Minimum 10 No of Boreholes and 8 No of ERT	10 to 15 m	
11	Coal Handling Plant	Minimum 1 borehole under each TP and 1 under each crusher and 1 borehole under each structure. Minimum 10 no of under each stockpile area, 1 in each WT	20 to 30 m	
12	Transformer yard	Minimum 8 boreholes and 8 No of ERT	10 to 15 m	
13	Water and effluent treatment and disposal plant	Minimum 6 no of borehole	10 to 20 m	
14	AWRS pump house, Control room building, swgr room etc.	4 Nos. boreholes, 3 Nos. ERT and 1 no PLT		
15	Fuel oil unloading and storage system	Minimum 2 Nos.	10 to 20 m	
16	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
b)	**Other Field Tests (Minimum)**			
1	Plate Load Test (PLT)	2 no in Power House, 3 Nos. in boiler area, 1 No. in CPU, 1 no each in each ESP and 3 Nos. in Ash Handling Structure area in Plant Area, 6 No in Balance of Plant area	Test Depth from 2 to 4 m	

2	Cyclic Plate Load Test (CPLT)	1 no in each TG, 1 no in each Mill, 1 no in ID fan, 1 no in each FGD	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 25 Nos.	Depth - 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 30 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 10.0m in other than wagon Tippler area. In Wagon Tippler area test shall be conducted at depths of 1.0m, 4.0m,7.0m, 10.0m, 13.0m,16.0m and 20.0m	
5	DCPT	About 10-20% of boreholes up to refusal depth		
6	ERT	6 Nos. in TG/Power House area, 6 nos. in Air cooled condenser, 1 No. in CPU Building, 2 Nos. each in Boiler, Chimney, ESP Control Room, 4 Nos. in Ash Handling Structures area in Plant area, 2 Nos in each FGD. 1No near each Pump House other than mentioned above		
7	CROSS-HOLE TEST	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 15.0 m	
8	PMT	80 no of tests in power house area, SG area & Balance of Plant area	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, Cross-Hole Test, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried

8.00.00 **GENERAL SPECIFICATION**

8.1.0 **General Requirements**

8.1.1 **Joints in Concrete Structures**

Construction Joints

All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.

For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small possible and the wall should be built to its full height in the least possible time.

Construction/ Expansion joints for all underground structures shall be made water tight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively. Two - part polysulphide sealant conforming to IS 12118 shall be used for sealing of joints. Preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler.

Expansions Joints

In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS 12118 or silicon sealing compound shall be used.

IS 3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.

8.1.2 **Miscellaneous General requirements**

8.1.2.1 All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti-corrosive paint before shipment to take care of sea worthiness.

8.1.2.2 Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.

8.1.2.3 Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.

8.1.2.4 Angles 75 x 75 x 6 mm (minimum) with 8mm dia and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.

8.1.2.5 Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.

8.1.2.6 Anti termite constructional measures and chemical treatment measures shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS 6313 and other relevant Indian Standards.

8.1.2.7	Trenches located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. The precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers. The trenches shall be given a slope of 1 in 250 in the direction perpendicular to the run of the trenches. PVC water stops shall be provided at all expansion joints of all trenches. Trench covers near entry or at road crossings shall be designed for 10 T wheel load at centre. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers.
8.1.2.8	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.
8.1.2.9	Duct banks consisting of PVC conduits conforming to IS 4985 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
8.1.2.10	Independent network of lines for sewerage and drainage shall be provided. Plant effluent shall not be mixed with either storm water or sewage.
8.1.2.11	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)
8.1.2.12	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS 9758 shall be followed as general guidance for dewatering.
8.1.2.13	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level. These shall be encased by concrete cover up to floor level with concrete grade M 25.
8.1.2.14	Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30. Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flowable grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/sq.mm at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.
8.1.2.15	Rail-track from transformer yard to unloading bay of Main Power House shall be provided with rigid type RCC foundation. Rail weighing 52 kg/m shall be used.
8.1.2.16	All building shall be design to take care of Rain Water harvesting & ground water recharging.
8.1.2.17	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.
8.1.2.18	All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays.

unless and noted otherwise

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.1.2.19	All internal cable trenches shall have minimum 6mm thick (o / p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer.
8.1.2.20	750mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.
8.1.2.21	All masonry walls shall be provided with Damp Proof Course at plinth level.
8.1.2.22	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.
8.1.2.23	Hand rail (of minimum 1m height), size and material to be adopted shall be as per general architectural specification.
8.1.2.24	In all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor with suitable floor drains.
8.1.2.25	All cable & pipe routing in outlying area shall be clubbed and shall run over ground on steel trestles or other supporting structures at a height specified elsewhere in this specification except in some localized area (as approved by Employer) where the same can run in trenches. In case cable route is not envisaged in the area, pipe shall be routed on ground over RCC pedestals at a height of not less than 500 mm. All trenches shall be of RCC with removable RCC covers.
8.1.2.26 Cl no 8.1.2.26 deleted	~~Water supply line, drainage & Sewerage line of buildings/ facilities shall be connected with the nearest Employer's water supply & drainage~~ line.
8.1.2.27	Unless specified all sand filling shall be compacted to minimum 80% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC.
8.1.2.28	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area.
8.1.2.29	Minimum 2.0m wide walkway with concrete paving shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL.
8.1.2.30	For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).
8.1.2.31 Cl no 8.1.2.31 deleted	~~All underground concrete structures like trenches, substructures of pump houses, all water retaining / carrying structures, etc., shall have super-plasticizer cum water proofing cement additive conforming to IS 9103. In addition, limit on permeability as given in IS 2645 shall also be met with~~.
8.1.2.32	40mm Diameter MS rods as earthing mat, placed at a distance of 1.0m away and at depths between 0.60m and 1.00m shall be supplied and laid all around the periphery of buildings, structures, and out door equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers of structures and equipment. The contractor shall also supply and lay necessary number of 3.0 m deep 40 mm diameter MS rods Earthing

electrodes and connect electrodes to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately at two locations.

8.1.3 **Acid/ Alkali Resistant Lining**

All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.

The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

8.2.0 **Concrete**

General

a) Concrete work shall be carried out as per IS 456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.

b) Minimum grade of reinforced cement concrete for all foundations shall be M25 unless noted otherwise. Minimum grade of concrete for other structures/areas (other than machine foundations) shall be M25 for all superstructure and substructure unless noted otherwise elsewhere in this specification.

c) The minimum grades of concrete for different machine foundations and some of other important structural members shall be as follows:

Sl No	Description	Minimum grade of concrete
i)	TG top Deck / Substructure & Raft	M-35
ii)	BFP foundations (in case of springs supported) / (in case of block foundation)	M-35 / M-30
iii)	ID, FD, PA fan & Mill foundations (block foundations)	M-30

d) Higher grade of concrete than specified above may be used at the discretion of the Bidder.

e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.

f) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.

h) **REINFORCEMENT COUPLERS:**
Reinforcement couplers (mechanical splicing systems with upset parallel threaded couplers) may be used in reinforced concrete works, subject to following conditions:
a. Couplers shall meet the performance requirements of IS 16172:2014 for class H.
i. It shall have minimum tensile strength corresponding to Fe550D which is 600 N/mm2 and failure shall take place outside the length of splice as per clause no 9.2.1 of IS:16174.
ii. Percentage elongation at maximum force in the reinforcing bar outside the length of mechanical splice shall be minimum 3 % before the failure of test piece as per clause no. 9.2.2 of IS:16174.
iii. Slip test value shall not exceed 0.10 mm. as per clause no 9.3 of IS:16174.
iv. Cyclic tensile test corresponding to Fe550D reinforcement bar as per clause no 9.4 of IS:16174.
v. Low cycle fatigue test as per clause no 9.5.1 of IS:16174.
vi. High Cycle Fatigue test as per clause no 9.5.2 of IS:16174.
b. The manufacturer shall mark the coupler in such a way that all finished reinforcement couplers can be traced to the original cast from which they were made along with date of manufacture.
c. Sampling and other requirements of IS 16172:2014 shall be complied with.
d. Each lot shall be supplied with manufacturer's test certificate (MTC) indicating values of tests in line with IS 16172:2014.
e. The minimum clear cover requirements are to be ensured for reinforcement couplers also.
f. The couplers shall be used only at the locations where joint is required as per standard lapping purpose and couplers shall not be used for joining of several cut pieces of reinforcement in a single bar. As a general guideline, the length of the bars in which coupler is to be provided should not be less than 4m. Vendors for the reinforcement couplers shall be subject to the approval of Engineer-In-Charge

g) Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

Special requirements for concreting of major equipment foundations shall be as given below.

a) **Temperature Control of Concrete**

For top decks of TG & BFPs, the temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C in the top decks of machine foundations, crushed ice shall be used in mixing water.

b) **Admixture**

Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-retarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG & BFP	-	150 mm to 180 mm
Block foundations	-	100 mm to 150 mm
TG Column	-	100 mm to 150 mm

c) **Form work**

Plywood with film face form work shall be used for the top decks of all machine foundations and also for columns of TG foundation.

d) **Placing of Concrete**

Base Raft and top deck of machine foundations shall be cast in a single pour.

e) **Ultrasonic Testing**

Ultrasonic pulse velocity test shall be carried out for TG top deck including TG Columns & BFP top decks (in case of Block type, UPV testing is not required) to ascertain the homogeneity and integrity of concrete. In general, grid spacing of 1.0m to 1.5m may be adopted for carrying out the UPV testing. In addition, additional cubes (at the rate of one cube per 150 cu.m. of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.

f) **Scheme for Concreting**

Weigh Batching Plants, transit mixer, concrete pump shall be mobilised. Arrangements for standby Plant and Equipment shall also be made.

8.03.0 **Formwork**

Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.

Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)

Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness of 0.80mm. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification.

The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

Type 2 Formwork: (For RCC Buildings)

Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings

8.4.0 **Not Used**

8.5.0 **Fencing and Gate**

Fencing

Fencing with gate shall be provided around transformer yard, switchyard area, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable

R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.

Toe walls either of brick masonry with bricks of minimum 50 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings.

Gate along fencing

All gates shall be of structural steel of minimum 3.75 metres width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS:513.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.

8.6.0 **Grating**

All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm for indoor installation and 32 mm for outdoor installation. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting.

8.7.0 **Fabrication**

The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.

All steel structures shall be fabricated in factory, transported and erected at site. All factory fabricated structures shall have bolted field connections. Bunker/Hopper segments shall be fabricated in factory, transported and assembled at site.

~~The factory referred above shall be in operation for the last two (2) years from the date of techno-commercial bid opening. The factory shall have the following facilities:~~

~~a) Multi-Axis Drilling Machine(Computer Numeric Controlled)~~
~~b) Quality Set-up for carrying out necessary Non-Destructive Tests like Dye Penetration Tests, Ultrasonic Tests, Radiographic Tests etc.~~
~~c) Heat Treatment facilities~~
~~d) Area for Pre-Assembly bed~~

Coal bunkers with hoppers and chimney flue liners can either be fabricated at factory in segments, transported and welded at site before erection or fabricated at site. For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/fle gas leakages, the applicable field joints shall necessary be welded.
Note: steel structures shall mean Plant and Non plant building structures, Boiler & ESP support structures, CHP structures, AHP structures, Chimney flue liners support platforms & stairs, pipe and cable support structures.

Welding

a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant.

b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal / transverse butt joints for fabrication of columns, framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

c) Wherever welding is done for assembling the components of structures, the job shall so positioned that downhand welding is possible.

d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded.

e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny.

f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly.

g) The members to be jointed by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

Electrodes

a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm.

b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 2500C - 3000 C for one hour and later on cooled in the same oven to 1000C. It shall be transferred to an holding oven maintained at 600C - 700C. The electrodes shall be drawn from this oven for use.

c) Where coated electrodes are used they shall meet the requirements of IS:814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage.

d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing

e) Where bare electrodes are used, these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 Class of AWSA-5-17-69 and IS:3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively.

g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started.

Preheating inter-pass temperature and post weld heat treatment.

a) Mild steel plates conforming to IS:2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I.

However, higher preheat and interpass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

c) Base metal shall be preheated, not withstanding provisions of IS:9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress.

TABLE – 1
MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING

Thickness of thicker part at point of Welding	**Welding using Low hydrogen electrodes or Submerged arc welding**
Upto and including 20mm	None
Over 20mm and upto and including 40m	20 ^{0}C
Over 40mm and upto and including 63mm	66 ^{0}C
Over 63mm	110 ^{0}C

c) Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending upto a distance of four times the thickness of the plate on either side of the welding joint is obtained.

d) Thermo-chalk, thermo-couple or other approved methods, shall be used for measuring the plate temperature.

e) All butt welds with plates thicker than 50mm and all site butts weld of main framing beam shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done upto 600 deg.C and rate of application shall be 200 deg.C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5cm. thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas.

Sequence of Welding

a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.

b) Each case shall be carefully studied before finally following a particular sequence of welding.

c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.

d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.

e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed.

f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.

i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement.

j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.

k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However,

partial penetration butt weld shall be permitted, when specifically shown in the design drawings.

l) Intermittent welds shall be permitted only when shown in the design drawings.

m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.

Testing of Welders

All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX/AWS D1.1. All the necessary arrangements required for the testing of welders are to be provided by the Bidder.

Inspection of Welds

a) **Visual Inspection**

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the welds run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, stages on the surface and visible cracks.

Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag, etc., If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken.

b) **Production Test Plate**

Test plates shall be incorporated on either side of at least one main butt welds of each flange plate and web plate of every main frame columns and crane girder. The weld shall be continuous over the test plate. The test plate extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Engineer or his authorised representative. Should any of these tests fail, further radiographic examination of the welds shall be done. These tests for test plates and radiographic examination are additional to those contemplated under inspection and testing.

c) **Non-destructive and special testing**

Radiographic / ultrasonic or other non-destructive examination shall be carried out. All tests of welds shall be carried out by the Bidder at his own cost. The cordoning of radiation zone, while Radiography testing is going on, shall be done.

In case of failure of any of the tests, re-testing of the joints shall also be carried out after rectification is done.

d) **Rectification of defective welding work**

Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc., are noticed by visual inspection/other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes.

Inspection and Testing

a) **Fillet Welds**

i) All fillet welds shall be checked for size and visual defects.

ii) Macroetch examination on production test coupons for main fillet weld with minimum one joint per built up beam, column and crane girder, etc.

iii) 25% weld length of tension members of crane girder shall be subjected to dye-penetration test.

iv) On all other welds, dye-penetration test on 5% of weld length with minimum 300mm at each location shall be carried out.

b) **Butt Welds**

i) 100% visual examination.

ii) Dye penetration test on all butt welds after back gouging shall be carried out.

iii) Mechanical testing of production test coupons - minimum one joint/built up beam, column and crane girder. The engineer may reduce the frequency of the test, after getting consistently satisfactory results of initial 10 tests.

iv) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder and bunker supporting girders. All other butt welds shall be subjected to radiography test on 10% of weld length of each welder.

c) **Dimensional Tolerance and Acceptance Criteria of Welds**

i) Every first and further every 10th set of identical structure shall be checked for control assembly at shop before erection.

ii) All structures, components/members shall be checked for dimensional tolerance during fabrication and erection as per IS:7215 and IS:12843 respectively.

iii) Dry film thickness after painting shall be checked by using elchometer.

iv) Acceptance criteria of NDTs on welds shall be as per AWS D-1.1 (Dynamically loaded structures - Tension welds).

Correction of Defective Welds

Correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed magnetic particles inspection or any other equally positive

means shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed.

Painting

a) Surface treatment and painting before and after delivery to site shall be in accordance with Clause no. 6.4.0 above. All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. ■

b) For parts to be bolted, the surfaces in contact shall be provided with ethyl Zinc silicate primer as specified in clause 6.4.3 (a) and shall be free of oil, dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts. For design of friction type bolted joints slip factor for surfaces with ethyl zinc silicate primer as given in IS 4000 shall be considered.

c) Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly. However, interior surfaces of Box-sections, which are effectively sealed from all ends, need not be painted.

■ **However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance in thickness(over the design thickness) of structural steel members shall be kept except for tubular and hollow sections where ends are completely sealed with end plates.**

Bolting

The threaded portion of each bolt shall project through the nut by at least one thread. Approved high strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations.

When connections are made using high strength friction grip bolts the relevant standards shall be observed.

Erection of Structures

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

d) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc., Bidder shall take up the erection work only after he has obtained the approval of the erection scheme from the Engineer.

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc.,

along with disposition at the time of erection of columns, trusses, etc.

c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

8.8.0 Steel Helical Springs and Viscous Dampers Units

8.8.1 General Requirement

This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units.

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

8.8.2 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 : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

ISO : 10816 Criteria for assessing mechanical vibrations of machine.

ISO : 1940 Criteria for assessing the state of balance of rotating rigid bodies.

8.8.3 Design & Supply of Material

i) Supply

Steel helical springs and viscous dampers and associated auxiliaries shall consist of:

(a) Steel helical springs units (fully pre-stressable) and viscous dampers units 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. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.

The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 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 spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1.

8.8.4 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.

8.8.5 The Springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

8.8.6 Transportation

Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.

8.8.7 Erection and Commissioning

Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor.

The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period".

8.8.8 Supervision

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

8.8.9 Realignment of Spring System

If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.

8.8.10 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.

Manufacturer's test certificate (MTC) shall be 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.

9.00.00 **Architectural Concepts and Design**

9.01.00 For Architectural Concepts and Design refer to 5.00.01 in this specification.

9.02.00 **General Architectural Specifications**

9.02.01 **General**

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing ht to be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanised as per IS : 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level.

In Service Building, Administrative Building, Plant Auditorium and Canteen Building RCC stairs and passages/ corridors hand railing with posts shall be made of stainless steel and be 1200mm high. For Atrium areas, same shall be provided with 10mm thick laminated Glass infill panels.

For RCC stairs, passages & Atriums in buildings, around all floor openings at operating floors, 1000 mm /1200mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided. The spacing of vertical posts shall be 1500mm. Two number of horizontal rails shall be provided including the top member.Toe guard and kick plate shall be provided above the floor level.

b) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise. For Administration Building& Service Building, stairs width shall be minimum 1500 mm, with Riser 150mm and Tread 300 mm.

c) All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb at the edge of the floor along the metal cladding. 1000 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view.

d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC staircase shall be provided for main entrance of Turbine building; control tower area and all other RCC construction buildings.

f) Parapet, Chajjas 450mm over window and 600mm door heads, 900mm over rolling shutters, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In

detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

h) Ramps & Lifts for physically challenged persons shall be provided for barrier free access to the buildings.

9.03.00 **Water Supply and Sanitation**

9.03.01 Two numbers of roof water tanks (one for storing service water and another for potable water) of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. ~~The tanks shall be complete with all fittings including~~

For Administrative Building, Service Building, Canteen Building, Gate Complex & Time office Building, IT Building , water tank shall be in R.C.C structure with capacity as per National Building Code

Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required.

UPVC (conforming to IS 13592) shall be used for sanitary works above ground level.

~~Sand Cast Iron pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level~~. All Buildings shall be designed with Toilets as per NBC norms.

Minimum one number main toilet block for Gents & ladies separately, with required facilities shall be provided on each floor of Service building Administration building and Canteen building. Toilets for physically handicapped shall be provided as mentioned. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.

9.03.02 Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (fancy type). For GRIHA rated Buildings all fittings shall conform to GRIHA requirements, for water efficiency. The toilet fixtures and facilities shall be as per NBC for Admin, Service, Canteen, Auditorium, IT Building and Time Office

a) One number wall mounted coloured (excluding premium colours) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556

b) One number colour (excluding premium colours) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 18mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However for Pump Houses the same shall be provided without photo voltaic control system for water control.

c) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS:2556.

d) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser

e) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements

f) 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:

g) Janitor Space & space for drinking water cooler.

h) Electric operated hand dryer with photo voltaic control.

i) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number HDPE loft type / over head water storage tank, as per IS : 12701 and of 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, GI concealed water supply pipe of minimum 12 mm dia of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless

Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

j) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556 (Part-5).

k) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage.

9.04.00 **Flooring**

Floor finishes of approved shade and colour (~~non – premium colours~~), over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.

9.04.01 The nominal total thickness of floor finish shall be 50 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade. Stone chips shall be 12.5 mm down well graded(& proper filling shall be done with brick bats/cinders). Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.

9.04.02 Sunken slabs shall be made water tight by suitable water proofing treatment.

9.04.03 Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)

9.04.04 Heavy duty cement concrete tiles 300 mm x 300 mm shall be in using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS:1443.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.04.05	Heavy duty (grade-5) dust pressed ceramic tiles (300mmx300mm shall be as per IS 15622. Designer ceramic wall tiles of size 300 mm x 200 mm / (300x600mm).
9.04.06	20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar, pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar up to a depth of 20 mm and bituminastic end sealing.
	9.4.7 (i) Mirror polished Doubly charged & Matt Finish Vitrified ceramic tiles (minimum 9.5mm thick) with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout mix of 0.70Kg of organic coated filter of desired shade (0.10kg of hardener and 0.20kg of resin per kg) with sizes of the tiles shall be as under: a) 600 mm x 600 mm b) 800mm x 800mm 9.4.7 (ii) Anti-Skid Full Body Vitrified Tiles Antiskid, full body Vitrified Tiles of size 600X600X20 mm thick as specified below of approved make, shade, colour and pattern, over under bed of cement mortar / PCC shall be provided in TG Hall flooring at operating level. Full body Vitrified Tiles shall be laid on properly laid leveled floor, with joints 3 to5 mm wide & 8 to10 mm deep & shall be filled with approved Epoxy Grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardner and 0.20 kg of resin per kg).Full body Vitrified Tiles shall have water absorption less than 0.5%, Modulus of Rupture more than 38N/mm2, Breaking strength more than 7500 N, Moh's scale more than 6, Abrasion resistance less than 144 mm3 and coefficient of friction more than 0.4. Vitrified Tiles shall generally conform to IS:15622
9.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.
9.04.09	PVC flooring, wherever used, shall be minimum 2 mm thick (virgin) as per IS: 3462. The laying of flooring shall be as per IS: 5318.
9.04.10	**Epoxy Flooring** Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer. It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.
9.04.11	Wherever required, carpet flooring shall be provided over cement concrete floor as in conference room of main control room complex. The carpet shall be of tile/roll form, machine/hand made tupled un-cut loop pile and lay with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.
9.04.12	Mirror polished (6 layers of polish) Granite stone (slab) - 18 mm Thk (minimum) / Flame finish/ (making top surface rough by burning)/ honed finish granite stone (slab) - 18 mm Thk (minimum) shall be provided.
9.04.13	~~18 mm thick shall be provided in main stairs & 18mm thick kota stone shall be provided as specified~~. Cl No 9.04.13 Deleted
9.04.14	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.
9.04.15	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto Up to false ceiling level height from finished floor level. Skirting and Dado shall match with the floor finish.
9.04.16	Providing and fixing removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment upto 50 mm,

comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I.Pedestal etc. all complete, as per the architectural drawings, as specified and as directed by Engineer-in-charge consisting of :

a) Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment upto 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy based adhesive of approved make or the machine screw with rawl plug.

b) Stringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the grid formed by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer-incharge.

c) Providing and fixing Access Floor panel of 600x600x32 mm medium grade Filled Steel anti static high pressure Lamination of 800H grade (FS800H). Access Floor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7 mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be Corroresist epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with Pyrogrip noncombustible Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High Pressure laminate with Non Warp technology upto 1mm thickness for superior adhesion and Surface flatness within 0.75mm.The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer-in-charge. All specification must be printed on the side of the panel to ensure the quality of the product.

9.04.17 Interlocking concrete blocks shall be of various sizes and thickness having M 35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.

9.04.18 Matt finish (with grooves) Porselin tiles (for guiding band/s for visually impaired persons) shall be with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile.

24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern.

11 mm thick Laminated wooden flooring shall be provided in VIP area, conference rooms & auditoriums. In Auditorium Wooden Flooring shall be as per acoustical requirement in stage portion.

9.04.19 **Paving**

a) Ground floor of all buildings shall be provided with normal duty paving with 50mm thick metallic hardener floor finish. For details of normal duty paving refer to description elsewhere in this specification.

b) PCC paving of nominal mix M15 grade, 100 mm thick laid over 75 mm thick bed of dry brick aggregate shall be provided for following areas:

i) 750 mm wide plinth protection around all buildings other than those covered under paved area.

ii) 2.0 m wide pathway all along pipe/ cable corridor and all around each cooling tower. 2.0 mm wide ways inter connecting all cooling towers with each other.

9.05.00 **Acid/ Alkali Resistant Lining**

9.05.01 The material shall conform to the following:

i) Bitumen primer shall conform to IS: 158.

ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.

iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.

iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.

9.05.02 Requirements for acid/ alkali resistant flooring and lining for different areas shall be as given Table-A enclosed at the end of this specification. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.

9.06.00 **Roof**

9.06.01 Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile having minimum base metal thickness of 0.8mm of galvanised (with minimum rate of galvanisation of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.

9.06.02 Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM - C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include

application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade conforming to IS: 13801 shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

9.06.03 For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.

9.06.04 Medium class galvanized mild steel pipes 150Dia conforming to IS 1239/IS3589 with welded joints shall be provided to drain off rain water from the roof. These shall be suitably concealed with masonry work, cement concrete/ or sheeting work to match with the exterior finish.

~~concrete / or sheeting work to match with the exterior finish~~. The number and size of down comers shall be governed by IS 1742 and IS 2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures.

9.06.05 Roof of the specific buildings shall conform to minimum 3 star GRIHA Rating shall have Over-deck insulation of minimum 40 mm thick impervious sprayed close cell free rigid Polyurethane foam confirming to IS: 12432 –III, with density of foam 40 TO 45 KG/ cum.Over-deck insulation with 40 mm thk polyurethane foam with density of 40-45 kg/cum shallbe fixed over a coat of polyurethane primer applied @ 6 to 8 sq.m/ litre, laid over cement screed, laid in slope above the cleaned roof top. 400g polythene sheet shall be laid over polyurethane spray and provided with a wearing course of 40 mm thick cement screed1:2:4(1 cement:2 coarse sand:4 stone aggregate 20 mm nominal size) in chequered rough finish, in panels of 2.5mx2.5m and embedding with 24 G wire netting and sealing the joints with polymerized mastic.

Heat resistant tiles of (300mm x300mm x20mm) with SRI (solar Refractive Index)> 78, Solar reflection >0.7 and initial emittance >0.75 on sloped screed surface of terrace at all levels, laid on 20mm thick cement sand mortar in the ratio of 1:4 (1 cement : 4 coarse sand) shall be provided on terraces of GRIHA rated buildings. The joints in the tiles has to be grouted with mix of white cement and marble powder in the ratio of 1:1. The surface shall be rubbed and polished up to three cuts complete. Skirting 150mm along the parapet walls shall be provided in the same manner.

9.06.06 **Roof Water Proofing**

Roof water proofing treatment shall be as follows:

a) For roofs having structural slope:

Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

b) For roofs having no structural slope:

Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also

9.06.07 Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.

9.06.08 RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.

9.06.09 Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.

9.06.10 Pathways for handling of materials and movement of personnels shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm .

9.07.00 **Walls**

9.07.01 All walls shall be non-load bearing infill panel walls.

9.07.02 For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever metal cladding is specified.

9.07.03 All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).

9.07.04 For Administration building, Service Building, Auditorium Building and Canteen Building Autoclaved Aerated Concrete blocks shall be used. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm. thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part-III) .The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (100 mm /125 mm thk.) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry , joint reinforcement etc. in the AAC masonry work strictly be carried out as per instructions laid down in .I.S 6041 – 1985, I.S -1905.

9.07.05 External wall of control room , control equipment room and ~~ESP building wall~~ shall be of factory made composite modular light weight aerated concrete panels,(minimum 2 hours of fire rating) consisting of 2 fiber reinforced cement sheets (minimum 4 mm thick) on either side of light weight concrete core, having minimum compressive strength of 35 Kg / Cm2 and the density in the range of 700-900 Kg. / cu.m. ~~of the thickness and fire rating as specified below, to provide external wall and internal partition at all levels~~, capable of sustaining wind pressure ~~of 4.50 M height (H)~~ within limiting deflection of span/250, fixed in position in tongue and groove

AC panels shall be minimum 75mm thick and 3.0 M height,

	jointing system by screwing the panels to top and bottom U channels, (channels minimum 1.25 mm thick and galvanised to grade 180 (minimum) as per IS : 277), fixing U profiled top and bottom channels to concrete / primary steel members which are placed at the maximum vertical spacing of 3 m with the help of galvanised steel expansion fasteners, filling the joints from both faces with silicon acrylic paste and making the same water tight by covering with fibre glass tape (minimum 50 mm wide and minimum 0.5 mm thick) or by any other suitable material, so as to ensure that the entire construction done with the light weight aerated concrete panels are weather proof and panel surfaces are flush for painting, creating opening for doors / windows /ventilators / ducts / pipes/fans/AC etc. and finishing the opening face with the same U profiled galvanized steel channel which is used at the top and bottom.
9.07.06	For Main plant building, Control tower and other buildings, the type, thickness and initial height of external cladding facing the transformer yard shall be according to the requirements. External face of Toilets, Air-conditioned and pressurised areas shall be provided with masonry wall as per functional / aesthetic requirements. (Inside the metal cladding wherever provided).
9.07.07	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS:702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.
9.08.00	**COLOUR COATED AND OTHER SHEETING WORK**
9.08.01	**Material** **a) Wall Cladding & Roofing Material** Troughed permanently colour coated sheet of approved shade and colour shall be **i)** either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 **ii)** or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 **iii)** or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254. **b) Metal Deck Roof Material** Troughed permanently colour coated metal decking sheets shall be **i)** either of steel with minimum 0.8mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as

per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275

ii) or of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275

iii) or of steel of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275.

Alternatively aluminium feed material of minimum bare metal thickness of 0.9 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254 can also be used for metal decking.

Thickness tolerance of (+/-) 0.04mm is permissible. However, all design calculations shall be carried out on the basis of lowest value of sheet thickness provided.

9.08.02 **Colour Coating**

Steel shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Polyester paint, of minimum 20 microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint systems shall be of industrial finish of product type 4 of AS/NZ2728.

9.08.03 **Design Criteria**

For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. The nominal depth of trough shall be 30 mm. However alternative profile meeting the strength, deflection and other functional requirements such as section modulus and moment of inertia shall be provided.

Sheet shall be of approved profile, sectional properties, colour and shade.

For profiled metal decking sheets (to be used for RCC floor slab **or roof slab**) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sq.m for two span condition. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.

For metal deck sheets used for roofing (with or without RCC) and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.

9.08.04 **Fasteners**

Side cladding/roofing/decking sheets shall be fixed to the runner/purlins using self-drilling special coated fasteners confirming to corrosion resistant class 3 of AS3566 and tested for 1000 hours salt spray test. Spacing of Self-drilling fasteners in transverse direction (along runners/purlin) shall be equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

Shear anchor studs shall also be provided through metal deck, which are to be used as permanent shuttering, at regular interval on all top flange / flange plate of structural beams as specified in Clause no. 8.03.00.

Alternatively, J/U type hooks shall be used in roofing which shall be provided in transverse direction (along runners/purlin) at a spacing equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

9.08.05 **Miscellaneous Details**

To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purlin / runner spacing.

Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.

Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 350 as per IS 277

Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets

. Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.

For insulation of cladding and other areas, mineral wool conforming to IS 8183 shall be used. The density shall be 32 or 48 kg. /cu.m for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the metal cladding. Overlap shall be min. 150 mm or as specified by manufacturer.

The contractor shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.

9.08.06 **Pre-Fabricated Insulated Metal Sandwich Panels**

For buildings where Pre-Fabricated Insulated Metal Sandwich Panels shall be used for Roofing, the sandwich panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated with 50mm thick insulation sandwiched between the two sheets. Each sheet shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per

AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150.

Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254.

Metal sheets (steel or aluminium) shall be colour coated with total coating thickness of at least 40 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of minimum 20 microns (nominal) SMP or polyester paint on one side (exposed face), over minimum 5 micron (nominal) primer coat and minimum 10 micron (nominal) SMP or Polyester paint over minimum 5 micron (nominal) primer coat on other side. SMP and Super Polyester paint shall conform to product type 4 of AS/NZS 2728. Troughed sheet shall be of approved profile, sectional properties, (suitable for the specified loading / deflection and purlins / runners spacing), colour and shade.

Special coated fastener conforming to corrosion resistant Class 3 of AS3566 and tested for 1000 hours salt spray test shall be used for fixing Pre-Fabricated Insulated Metal Sandwich Panels with the structural members below.

The contractor shall prepare working drawings of sheeting system including end and side laps, fixing details etc. before starting sheeting work at site.

9.08.07 **Polycarbonate Sheets**

The polycarbonate sheet to be used for cladding and glazing purpose in conveyor galleries, Transfer points & pump houses shall have toughed profile to match with the metal cladding profile. Minimum 3.0mm thick fire retardant and UV resistant polycarbonate clean sheet of approved make shall be used. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS 14434 to be referred for other details.

9.09.00 **Plastering**

9.09.01 Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.

9.09.02 Acrylic wall putty in two coats shall be applied over cement plastered surfaces in interior of building.

~~punning over cement plastered surfaces~~. The finish surface shall be smooth and shall be of 2 mm nominal thickness.

9.09.03 All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.

9.09.04 All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.

9.09.05 Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.09.06	All plastering work shall conform to IS:1661.
9.10.00	**Painting & Aluminium Composite Panel Cladding**
9.10.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.
9.10.02	All paints shall be of approved make including chemical resistant paint.
9.10.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer.
9.10.04 Cl No 9.10.04 Deleted	~~Solvent based (100% pure acrylic co-polymer resin based) paint shall not contain any water sensitive ingredients. Paint shall be applied in two or more coats as required on an under coat of suitable primer or one coat of cement paint on the new plastered surfaces inclusive of required tools, material and other painting accessories etc. The paint is to be applied as per the specifications, instructions and satisfaction of Engineer-in-charge.~~
9.10.05	Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 18 mm thk / polished Sadarhally grey granite slab 18 mm thk). The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.
9.10.06	Acrylic emulsion paint shall be as per IS:15489. Acrylic distemper shall be as per IS:428. Cement paint shall conform to IS:5410, white wash/colour wash shall conform to IS:627.
9.10.07 Cl No 9.10.07 Deleted	~~Fire resistant transparent paint as per IS:162 shall be provided on all wood work over French polish or flat oil paint. French polish shall conform to IS:348. Flat oil paint shall conform to IS:137~~.
9.10.08	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.
9.10.09	For painting on concrete, masonry and plastered surface IS:2395 shall be followed. For painting on wood work IS:2338 shall be followed.
9.10.10	For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.
9.10.11	Bitumen primer used in acid/alkali resistant treatment shall conform to IS:158.
9.10.12	All internal paints shall be of low VOC content conforming to GRIHA rating for reduction of VOC content.
9.10.13 Cl No 9.10.13 Deleted	~~Resin bonded granular textured finish, for external applications shall consist of crushed stone / quartz chips of 2.5 mm size and of approved colour/ shade and bonded with synthetic resins, Adhesives and additives, all together in a single pack mix. For internal finish 1.2mm of approved, colour & shade (pigmented granular or flake finish)~~ The final finish shall have UV-Resistant, fungus/bacterial resistant properties. Grooves shall be provided as per drawing and the same shall be filled with polysulphide sealant of matching colour/shade.

9.10.14

Aluminium Composite Panel

Aluminum Composite Panel cladding with open grooves shall be designed, fabricated, tested installed and fixed for linear as well as curvilinear portions of the building for all heights and levels including:

a) Structural analysis & design and preparation of shop drawings for pressure equalization or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design.

b) **Aluminium Composite Panel cladding in pan shape in metallic/ solid colour of approved shades made out of 4mm thick aluminium composite panel. ACP consisting of 3mm thick Fire Retardant mineral filled Core comprising of around 70% Inorganic compound which is 100% non-combustible mineral and balance 30% is food grade virgin polymer sandwiched between two Aluminium sheets (each 0.5mm thick). The aluminium composite panel top and bottom skin should confirm to Aluminium Alloy 5005 (AlMg 1) marine grade series and H 22/24 temper.**

The ACP sheet shall be coil coated with Kynar 500 based (70:30 ratio) PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc.

c) The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot Dip Galvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing .

Exterior Painting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives)

The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

Application of Base Coat

Base coat shall be of water proofing cement paint.

Preparation of Mix for Base Coat

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application of Base Coat

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Application of exterior paint

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.11.00	**Doors & Windows**
9.11.01	Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of all buildings (unless otherwise mentioned) shall have, electro colour dyed (anodised with 15 micron coating thickness) aluminium framework with glazing. All doors of toilet areas shall be of steel framed solid core flush shutter. For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided.
9.11.02	Main entrance of the common control room and control equipment room of MPH shall be provided with air-locked lobby with provision of double doors. Automatic Sliding Doors with Fire Resistant glass shall be provided. Control Rooms of all other buildings shall be provided with Aluminium Glazed door.
9.11.03	Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.
9.11.04	a) The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS:4351. b) All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc.
9.11.05	Steel windows and ventilators shall be as per IS:1361 and IS:1038.
9.11.06	Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.
9.11.07	All windows and ventilators on ground floor of all buildings shall be provided with suitable Aluminium grill.
9.11.08	Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall generally be as per IS:3614 Part-II. Fire rating of the doors shall be of minimum 2 hours. These doors shall be double cover plated type with mineral wool/wood insulation.
9.11.09	Hollow extruded section of minimum 2 mm wall thickness as per IS:1285 shall be used for all aluminium doors, windows and ventilators.
9.11.10	Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.
9.11.111	Electrically operated, self operable/closing, aluminium framed with tinted glass . sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building.
9.11.12	Fire Doors shall be provided in staircases of Service & Admin Building with Fire Resistant glass with suitable fire resistant frame.
	9.11.13 wooden fire door shall be provided in Auditorium Hall

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.12.00	**Glazing**
9.12.01	All windows and ventilators located in fire prone areas shall be provided with minimum 6 mm thick toughened glass conforming to IS:5437.
9.12.02	For single glazed aluminium partitions and doors, 8mm or 10 mm thick clear toughened glass shall be used.
9.12.03 deleted	9.12.03 ~~Ground glass of minimum 4 mm thickness shall be used for all windows/ventilators in toilets~~
9.12.04	All glazing work shall conform to IS:1083 and IS:3548.
9.12.05	For main plant glazings, 6mm thk clear reflective toughened glass shall be provided. The glass to be used should be from the manufacturers of glass like Saint Gobain (India) or Asahi (India) or equivalent. The glass should be free from distortion and thermal stress. Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28)
9.12.06	For glazings of Air Conditioned Buildings Composite double glazing shall be 24mm thick consisting of 6mm thick clear float glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminium with outer edge sealed with silicon sealant. Outer glass of 6mm thickness shall have following technical characteristics: Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) The glass to be used should be from the manufactureres of glass like Saint Gobain (India) or Ashai (India) equivqlent. The glass should be free from distortion and thermal stress. For CER & Control room, Fire resistant glass partition shall be provided. The fire glass panels shall be min 11mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control (EW120) with min 15 minute full insulation (EI15) , non wired toughened glass complying to BS476 Part22 or (EN-1634-1 :1999). The glass shall be complied to Class 2B2 Category of Impact Resistance to as per EN 12600 safety Glazing Material. The Glass shall have a light transmission ratio of approx. 86% according to EN410 standards and sound reduction of >=37 dB.. The partition frame frame shall be manufactured of 1.6mm thick galvanized steel sheet (zinc coating not less than 120 gm/sqm) pressed to form a profile of section 35 mm x 60 mm on the vertical sides and 50 x 60 mm on the horizontal side suitable for mounting 120 min Fire Rated Glazed Door Shutter. The Frame shall be filled with mineral wool insulation having density min 96kg/m3. The door frame will have a provision of GI anchor fasteners 14 nos (5 each on vertical side and 4 on horizontal side of size M10x80) suitable for fixing in the opening with Factory made template for SS Ball Bearing Hinges of size 100x89x 3 mm for the fixing of fire rated glazed shutter. The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade.
9.12.07	Glass block masonry work with glass blocks of size 190 x 190 x 90 (min), jointed with suitable adhesive complete as per the best construction practices.
9.12.08	For internal glazed partition, 8mm thick clear toughened glass shall be provided.
9.12.09	For Automatic Sliding doors 12 mm thick Toughened glass shall be provided.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.12.10	Glass to be used in Admin and Service atrium railing shall be Laminated glass with 6mm heat strengthened glass + 1.52mm pvb layer + 6 mm heat strengthened glass of approved make
9.13.00	**False ceiling**
9.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum 0.8 mm thick and galvanised as per IS : 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS : 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome)
9.13.02	False ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanised light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600. as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete.
9.13.03	False ceiling of 12 mm thk calcium silicate board of 'HILUX' or equivalent with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).
9.13.04	S. No. 89 of Amendment 3:Providing and fixing GI Clip in Metal Ceiling System of 600x600 mm module (of Armstrong/ Hunter Douglas/ Durlam make) which includes providing and fixing `C' wall angle of size 20x30x20mm made of 0.5mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300mm center to centre, suspending the main C carrier of size 10x38x10mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600mm centers with
9.13.05	Pre-Painted Coil coated Steel false ceiling system, at all level, for all kind of works, consisting of 0.5 mm thick galvanised as per IS : 277, along with galvanised supporting steel members exposed faces of galvanised member to be prepainted with regular modified polyester coating / super polyester coating minimum 20 DFT, to form panels of specified size for tile type panels and roll formed stove enamelled 0.6 mm thick steel carrier, for fixing of lineal type panels by clip on arrangement, suspended from RCC slab / structural steel or catwalk way steel channel grid above with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm leg width along the perimeter of ceiling, including all labour, material, supporting grid system (members minimum 0.8 mm thick and galvanised as per IS : 277) anchor fasteners for making suspension arrangement from RCC, providing openings for AC ducts, return air grills, insulation light fixtures, etc., all complete.
9.13.06	Tile type steel false ceiling system in square pattern panels of 600 mm x 600 mm size along with galvanised light gauge rolled form. supporting system in double web 'T' construction with pre-painted steel, with Tee support.

help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive) Fixing with clip in tiles into spring 'T' with GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5mm thick with 25mm height, made of G I sheet having galvanizing of 100 gms/sqm (both sides inclusive) and 20% perforation area with 1.8mm dia holes and having NRC of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation and backed with a black Glass fiber acoustical fleece

9.13.07 Lineal pattern (closed type) of 100 mm nominal width, with carrier support. Metal ceiling as above in lineal/tile shape in stainless steel, bright finish instead of pre-painted coil coated finish.

9.13.08 Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.

9.13.09 Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.

9.12.10 Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thk. mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.

9.13.11 Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.

9.14.00 **Interior Design**

A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the mutlidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance.

The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification.

a) Layout, keeping in view the man-machine interface and suitable ergonomic practices.

b) Integration of civil engineering with architecture and interior design.

c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.

d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc.

e) Microprocessors based control system to control the functional requirements.

The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.

9.15.00 **Stainless Steel Hand railing**

Providing and fixing knockdown railing system comprising of SS 304 Grade Stainless Railing of 50mm dia handrail fixed on 50 mm SS round baluster placed at maximum 1000 c/c along

	with three numbers 19 mm dia midrail connected at side of baluster by special brackets, both the end of mid rail should be bush inserted for jointing and to give extra strength (joints should not be welded and invisible). The balustrade should be fixed onto floor with casted plate of minimum 6mm thickness. Base plate shall be concealed with suitable SS 304 cover cap so that the mounting height fasteners are not visible after installation. Only high strength anchor fasteners would be used for fixing of baluster, as giving extra strength, rust proof and more durable. Onsite welding is strictly not allowed. Wherever welding is required, it should be Tig welding process with same grade 304/316 at factory only so that floor stone and other things would not be damaged and for safety purpose also. Baluster and handrail connector should be screwed tightened and not to be welded on site. Railing should be tested for appropriate load testing criteria as per international railing standard from EXOVA. Wall thickness of all pipes shall be taken as 2 mm. Along with all visible components developed in high grade SS and whenever required, joints to be filled with bushings for extra strength. Railing Height to be taken @ 1000/ 1200 mm from floor level.
9.16.00	**Finishing Schedule** Interior and Exterior Finishes shall be as given in Tables-B & C respectively attached at the end of these specification.

TABLE – A
PROPOSED ACID /ALKALI RESISTANT TREATMENT

S.NO.	AREA	PRIMER (ONE COAT)	TYPE OF LINING AND THICKNESS				EPOXY COATING (TWO COATS)
	EFFLUENT TREATMENT PLANT		A.R. BRICKS	A.R. TILES	EPOXY MORTAR	BITUMASTIC	
1	CPU: a) Neutralisation Pit i) Floors	Bitumen	75 mm thick			18 mm thick	
	ii) Walls	Bitumen	115 mm thick			18 mm thick	
	iii) Ceiling	Epoxy					150 micron
	iv) Pillasters		115 mm thick				
	b) Effluent Drains	Bitumen		38 mm thick		12 mm thick	
	c) Floor around equipment & dado	Bitumen		38 mm thick		12 mm thick	
	d) Regeneration area floor & dado	Bitumen		38 mm thick		12 mm thick	

	e) Acid / Alkali storage area	Bitumen		75 mm thick		12 mm thick	
	f) Degasser area floor	Bitumen		38 mm thick		12 mm thick	
	g) Pedestals for supporting equipment	Bitumen		38 mm thick		12 mm thick	
	h) M.S. Grating / Chequered plate	Epoxy					150 micron

Note : -

1. The above table is for general guidance only, however, actual areas/ facilities to be covered shall be as per Scope of work.
2. Suitable end sealing shall be provided.
3. Structures shall be tested for waterproofing before application of Acid / Alkali Resistant Treatment.
4. This treatment shall be applied on dry surface.
5. For laying of AR bricks / tiles, the bedding mortar shall be of potassium silicate 6 mm thickness and the pointing mortar shall be of Epoxy / furane 20 mm deep and 6 mm thickness.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
1.	Main power house Building.			
	a)Unloading Bay	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	b)Cable vault	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	c)Balance area including passage	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	d)SWAS Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	GI clip in metal false ceiling in combination with GRG plaster border as per design
	e)Equipment Area, ESP SWGR/ ACP Room/ UAF Room	Cement concrete with Metallic hardener topping	Acrylic distemper.	Acrylic distemper (except metal deck area
	f) UPS Battery charger room	Vitrified ceramic tiles.	Acrylic emulsion paint in case of brick wall, Aluminium composite panel cladding on columns and on walls in case of A.C Panels	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	g)Deaerator floor	Cement concrete with Metallic hardener topping.		-

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	h) Operating Floor	20 mm thick Heavy duty Anti-skid Full Body Vitrified tiles.	Colour coated Metal cladding on A-Row& Gable end, up to crane girder level.	Metal deck roofing (bottom of sheeting with RAL 9002 finish)
	i) General circulation and movement areas	18mm thk. Polished granite honed finish combination as per design stone / marble stone/ Vitrified Ceramic tiles.		Acrylic distemper (except metal deck area).
	j) Switchgear room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	k) MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	l) Control room area including control room, computer room,	Vitrified ceramic tiles	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	m) control equipment room,	Vitrified ceramic tiles (Matt Finish) Partition	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	n) Conference room, senior executive room.	Vitrified ceramic tiles (Matt Finish)	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	o) Record room	Heavy duty dust pressed ceramic tiles	Acrylic distemper.	GI clip in metal false ceiling in combination with GRG plaster ~~border as per design~~ board border in column depth or as per approved design
	p) Locker room	Heavy duty dust pressed Ceramic Tiles	Acrylic Emulsion Paint	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	q) Toilet area	Heavy Duty Dust pressed ceramic tiles	Designer ceramic wall tiles up to False Ceiling Height	Calcium Silicate false ceiling.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	r) Office Room, Staff Room	Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	s) Laboratory area	Vitrified Ceramic / Acid/alkali resistant tiles.	Designer ceramic wall tiles up to False Ceiling Height/ Aluminium composite panel cladding for columns and walls in case of A.C Panel	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	t) RCC Stair case	18mm thick Granite (Polished and honed Finished) stone	Polished Granite Stone up to 1.2m. ht. & Acrylic Distemper Paint over wall putty finish for balance height.	Acrylic Distemper
	u)Lift and Staircase Lobby	18mm thick polished granite stone as pattern.	18mm thick polished granite & glass mosaic tile cladding upto False Ceiling Height	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	v)Passages and general circulation areas.	18mm thick polished Marble Stone/ granite stone.	Acrylic Distemper / acrylic emulsion paint.	-

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	w) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
	x)Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based) 150 micron over primer.	As above except oil canal Oil resistant Paint	As above except oil canal.
	y) Pathways including roof area.	22mm thick concrete chequered tiles.	-	-
2.	Service Building/ Admin Building/Auditorium Building			
	a) Entrance Lobbies and Lift areas/Foyer/Exhibition space.	18mm thick polished granite stone as/ pattern.	Textured paint /18mm thick polished granite cladding and glass mosaic tile murals in lift lobby & foyer	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	b) Conference room, senior executive room.	Laminated wooden fooring	Glazed partition with Aluminium frame/ Acrylic emulsion paint.	Mineral fiber board false ceiling in combination with GRG plaster board false ceiling.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	c) Office Room, Staff Room/Library/Canteen.	Vitrified ceramic tiles.	Acrylic emulsion paint./ Designer Glass mosaic tile mural in combination with textured paint in Canteen	Mineral fiber board false ceiling in combination with GRG plaster board false ceiling
	d) Passage	Vitrified ceramic tiles.	Acrylic emulsion paint.	GI clip in metal false ceiling in combination with GRG plaster ~~border as per design~~ board border in column depth or as per approved design
	e) RCC Stair case	18mm thick Granite (Polished and Flame Finished) stone	Glass Mosaic Tile cladding in murals and pattern	Acrylic Distemper.
	f) Toilet/ Pantry/ Kitchen	Heavy Duty Dust pressed ceramic tiles	Designer ceramic wall tiles dado up to false ceiling level	Acrylic distemper in kitchen / Calcium Silicate false ceiling in toilet and pantry
	g) AHU/ A.C. Plant room/MCC Room/Store	Cement concrete with Metallic hardener topping.	Acrylic distemper	Acrylic distemper
	h) Covered parking area	Pavers interlocking cement concrete blocks.	-	-
	i) Pathways including roof area.	22mm thick concrete chequered tiles.		
	j) Green Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	Mineral Fiber Board False Ceiling
	k) Seating Area	Cement concrete with Metallic hardener topping covered with carpet	Wooden paneling as per acoustic requirement.	Gypsum Board False Ceiling /Mineral fiber board false ceiling as per acoustic requirement.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	l) Stage	Cement concrete with Wooden flooring as per acoustical requirement	Wooden paneling as per acoustic requirement.	Gypsum Board False Ceiling /Mineral fiber board false ceiling as per acoustic requirement.
	m) Projector room	Heavy duty dust pressed ceramic tile	Acrylic distemper	Acrylic Distemper
3	ESP control building/Air compressor house			
	a) Operating/Maintenance areas	Cement concrete with Metallic hardener topping	Pre color coated metal panel cladding.	Acrylic distemper (except metal deck area)
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber Board False Ceiling
	c) Control Room	Vitrified ceramic tiles.	Acrylic Emulsion paint /Aluminium composite panel cladding on walls and columns in ESP Control Room Building	False ceiling in lineal Metal panel
	d) MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	e) RCC Stair case	Flame finish Granite Stone.	Polished Granite stone up to 1.2m.ht. & Acrylic Distemper	Acrylic Distemper (except metal deck area)
	f) Battery Room	Acid, Alkali resistant tile	Acid, Alkali resistant tile 1.2m height / chemical resistant paint above dado	Chemical resistant paint (except metal deck area)
	g) AHU/ AC Plant room/ Cable vault	Cement concrete with Metallic hardener topping	Acrylic Distemper	Acrylic Distemper (except metal deck area)
	h) Toilets	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling.
4.	Canteen/ Gate Complex/Fire station/Safety Centre/ FQA Lab			
	a) Reception/Waiting/ Corridors	Granite stone	Textured paint	Acrylic emulsion paint/GI Metal panel false ceiling in Canteen, Gate Complex and safety centre
	b) Office/Guard Room/Conference/Viewing Gallery/ Staff room /Class Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber board false ceiling. Acrylic emulsion paint for Fire station
	c) Detention Room/ Ammunition store/AHU/MCC Room/ Labs	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic Distemper

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	d) Sitting and General Area	Granite stone/Vitrified ceramic tiles.	Designer ceramic wall tiles up to 1.2 m, and Textured Paint for balance height. Glass mosaic tiles murals & Glass blocks for interior purpose in Canteen.	Acrylic distemper/ Gypsum board false ceiling./ Mineral Fiber Board false ceiling in Canteen and Gate complex and acrylic emulsion paint for Fire station
	e) Kitchen, and preparation area	Heavy duty dust pressed ceramic tiles and Granite stone for platform	Designer ceramic wall tiles dado upto 2.1 m. height and Acrylic distemper for balance area height. .	Acrylic distemper
	f) Toilets/ Pantry	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium Silicate false ceiling.
	g) Fire Tender area	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.
	h) Stores	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.
	i) RCC Stair case	18mm thick polished Marble stone.	Marble stone up to 1.2m.ht. & Acrylic Distemper above.	Acrylic Distemper
5.	CHP Maintenance Building /O&m store/O&M workshop building.			

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	a) Workshop/stores/dozer shed	Cement concrete with Metallic hardener topping.	Acrylic distemper/ color coated Metal panel cladding	Acrylic distemper (except metal deck area)
	Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	Acrylic emulsion paintMineral fiber board false ceiling/ Acrylic distemper
	b) Passages c)	Vitrified Ceramic Tiles	Acrylic distemper	Mineral fiber board false ceiling/ Acrylic distemper
	d) RCC Stair case	18mm thick polished Marble stone finish.	Marble stone up to 1.2m.ht. & Acrylic Distemper above.	Acrylic Distemper
	Toilets	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to 2.1 m Height from FFL.	Acrylic distemper
6.	a) Mill& Bunker building/Track Hooper/T.P./Conveyer's gallery/Crusher			
	a) Mill& Bunker area/Track Hooper area/ T.P. area/Conveyer's gallery area/Crusher area	Cement concrete with Metallic hardener topping	Acrylic distemper on masonry walls/ color coated Metal panel cladding	color coated Metal panel cladding

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper
7.	Fire water pump house a)			
	b) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Control room /PLC.	Vitrified ceramic tiles Epoxy flooring	Acrylic emulsion paint.	Mineral fiber board false ceiling.
	Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling
8.	Fire water booster water pump house. a)			
	b) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Control room /PLC.	Vitrified Ceramic Tiles	Acrylic emulsion paint.	Mineral fiber board false ceiling.
	Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
9.	a) Ash slurry pump house/ Ash water pump house / Silo Area Utility Building / Ash Water recirculation Pump House/ Transport air compressor house/ HCSD pump house/ Ash Dyke Maintenance building.			
	b) Operating/Maintenance areas/ MCC room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Acrylic distemper.
	d) Control room	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling.
	e) RCC Stair case	Marble stone / Granite stone.	Marble stone / Granite stone up to 1.2m.ht. & Acrylic emulsion paint	Acrylic Distemper.
	Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper over plaster of Paris for balance height.	Acrylic distemper.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
10.	a) Water & Effluent treatment plant buildings/Switch yard Control Building & Other auxiliary building.			
	b) Workshop/ Operating/Maintenance areas/MCC areas	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber board false ceiling.
	c) Control room d)	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling.
	e) Acid/Alkali storage area/ CW treatment area/DM plant area/ Regeneration area/ Neutralization pit etc.	Acid, Alkali resistant tile as per requirement.	Acid/Alkali resistant tile as per requirement and chemical resistant paint above dado.	Chemical resistant paint.
	f) RCC Stair case	Marble stone / granite stone.	Marble stone up to1.2 m.ht. & Acrylic Distemper paint.	Acrylic Distemper

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	g) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles up to false ceiling level	Calcium Silicate False Ceiling
11.	a) IT Building			
	b) FMS room/ IT operator room/IT Server Room/Telephone exchange room/Library/ IT Store/UPS Room/FMS Room/IT Kiosk/Cabins/Conference room/Testing & Repair/ Sect./Executive Hall HOD room etc.	Vitrified ceramic tiles.	Acrylic emulsion paint	GI clip in metal false ceiling
	c) Elect. Room/ OFC Cables & terminators/AHU etc.	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper
	d) MCC room	Cement concrete with Metallic hardener topping and False Floor	Acrylic distemper	Acrylic distemper
	e) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	f) Battery room	Acid, Alkali resistant tile	Acid/Alkali resistant tile and chemical resistant paint above dado.	Chemical resistant paint.
	g) Entrance/ Reception/ RCC Stair	Granite Stone	Acrylic emulsion paint and Glass Mosaic tiles cladding	GI clip in metal false ceiling
	h) Passages	Granite Stone and Vitrified Ceramic Tiles	Acrylic emulsion paint	GI clip in metal false ceiling

Note :

1. All wall and roof areas above false ceiling shall be plastered.
2. The colour and pattern of finish shall be as per approved details.
3. All materials shall be of reputed and established brand approved by Engineer-in-charge.
4. Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.
5. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
6. All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
7. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.

TABLE –C

EXTERIOR FINISHES SCHEDULE

Sl.No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Main plant building & Fire walls in Transformer yard; Other Auxilliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding
2.	Building with concrete frame work, etc.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface For Service building/ Admin. Bldg. / canteen, gate complex & Auditorium, Aluminium composite Panel Cladding in combination with Premium Acrylic Smooth exterior paint with silicon additives as per drawing	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface over suitable primer of water proof cement paint.

3.	Steel Structure, trestles, etc.	High performance Paint of approved specification and shade.	

NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer.

2. All materials shall be of reputed and established brand approved by Engineer.

10.00.00 MATERIAL SPECIFICATION

10.01.00 **Cement**

Fly ash based portland pozzolana cement conforming to IS:1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.

Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.

a) TG foundation top deck

b) Spring supported decks of all machine foundations such as TDBFP/MDBFP

c) RCC for Chimney shell.

d) NDCT shell and racker columns of NDCT.

The grade of cement shall be Grade 43 for OPC conforming to IS:8112.

In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS:3812(Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement

10.02.00 **Aggregates**

a) **Coarse aggregate**

Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

b) **Fine aggregate**

Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS : 383. For plaster, it shall conform to IS : 1542 and for masonry work to IS : 2116.

c) Petrographic examination of aggregate shall be carried out by the contractor at National Council for Cement and Building Materials (NCB), Ballabgarh, or any other approved laboratory to ascertain the structure and rock type including presence of strained quartz and other reactive minerals for machine foundations, etc. In case, the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining the rock type, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. The procedure laid down in IS 2430 for sampling of aggregates may be followed.

The laboratory shall determine potential reactivity of the aggregate, which may lead to reaction of silica in aggregate with the alkalis of cement and / or potential of some aggregates like limestone to cause residual expansion due to repeated temperature cycle. If the same is established, the contractor shall further carry out alkali

aggregates reactivity test as per IS 2386 (Pt.VII) and / or repeated temperature cycle test to establish the suitability of the aggregates for the concrete work. The test results, with the final recommendations of the laboratory, as to a suitability of the aggregate, for use in the concrete work for various structures and suggested measures, in case of results are not satisfactory, shall be submitted to the Engineer for his review, in a report form.

In case in the report, it is established, that the aggregates contain reactive silica, which would react with alkalis of the cement, the contractor shall change the source of supply of the aggregate or use low alkali cement as per recommendation or take measures as recommended in the report as instructed by Engineer. In case aggregates indicate residual expansion, under repeated temperature cycle test (from 10o Celsius to 65o Celsius and for 60 temperature cycles) the material shall not be used for concreting of TGs', BFPs', Mills', Fans' and other equipment foundations which are likely to be subjected to repeated temperature cycle. The contractor shall use aggregates free from residual expansion under repeated temperatures cycle test.

10.03.00 **Reinforcement Steel**

/ Grade 500 D

Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-500 and shall conform to IS:1786. However, minimum elongation shall be 14.5%.

Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade-1 of IS:432 (Part-1) or grade A of IS:2062. Welded wire fabric shall conform to IS:1566.

10.04.00 **Structural Steel**

Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.

10.04.01 Mild Steel

a) a)Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM -A578 level B-S2.

b) Pipes shall conform to IS: 1161.

c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240.

d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

10.04.02 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

10.05.00 **Bricks**

Only fly ash bricks shall be used in all construction. Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of **75kg/cm2**. Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS :13757 and IS:12894 respectively. Minimum fly ash content in fly ash based bricks shall be 25%.

10.06.00 **Foundation Bolts**

Material and details of foundation bolts shall conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS432 and/ or grade A of IS:2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 upto M36 diameter and IS 5624 for M42 to M150 diameter.

10.07.00 **Stainless steel**

The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.

10.08.00 **Water**

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS:456.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

10.08.00 **Statutory Requirements**

Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.

Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

11.00.00 **Inspection, Testing And Quality Control**

11.01.00 Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding), piling, sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.

The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.

11.02.00 Workmanship and dimensional shall be checked as stipulated below.

12.00.00 **ANNEXURES**

(a) List Of Codes And Standards

All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as given in Annexure-a of this specification.

Annexure-(a)

LIST OF CODES AND STANDARDS

Excavation and Filling

IS :2720	Methods of test for soils(relevant parts)
IS:4701	Code of practice for earth work on canals.
IS:9759	Guide lines for dewatering during construction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS:269	33 grade for ordinary Portland cement.
IS:383	Coarse and fine aggregates from natural sources for concrete.
IS:432	Specification for mild steel and medium tensile steel bars and
(Part 1&2)	hard drawn steel wires for concrete reinforcement.
IS:455	Portland slag cement.
IS:702	Industrial bitumen.
IS:712	Specification for building limes.
IS:1077	Common burnt clay buidling bricks.
IS:1161	Steel tubes for structural purposes.
IS:1239	Mild steel tubes, tubulars and other wronght steel fillting - MS tubes.
IS:1363	Hexagon head bolts, screws and nuts of productions
(Part 1-3)	grade - C.
IS:1364	Hexagon head bolts, screws and nuts of productions
(Part 1-5)	grade-A & B.
IS:1367 (Part 1-18)	Technical supply condition for threaded fasteners.
IS:1489 (Part-I)	Portland-pozzolana cement. Fly ash based
IS:1542	Sand for Plaster.

	IS:1566	Hard drawn steel wire fabric for concrete reinforcement.
	IS:1786	High strength deformed steel bars & wires for concrete reinforcement.
	IS:2062	Hot Rolled Low, Medium and High Tensile Structural Steel
	IS:2116	Sand for masonry mortars.
	IS : 2185 (Part 1) (Part 2)	Hollow & solid concrete blocks. Hollow & solid light weight concrete blocks.
	IS:2386 (Part I-VIII)	Testing of aggregates for concrete.
	IS:3812	Specification for fly ash for use as pozzolona and admixture.
	IS:4082	Recommendation on stacking and storage of construction materiel and components at site
	IS:8112	43 grade ordinary portland cement.
	IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).
	IS:12269	53 grade ordinary portland cement.
	IS:12894	Specification for fly ash lime bricks.
	IS:13757	Burnt clay fly ash building bricks.
	Cast in-situ Concrete and Allied Works	
	IS:280	Mild steel wire for general engineering purpose.
	IS:456	Code of practice for plain and reinforcement concrete.
	IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
	IS:516 IS:1199	Method of test for strength of concrete. Methods of sampling and analysis of concrete.
	IS:1791	General requirement for batch type concrete mixers.
	IS:1834	Hot applied sealing compound for joints in concrete.
	IS:1838	Preformed fillers for expansion joints in concrete pavement and structures.
	IS:2438	Specification for roller pan mixers.
	IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
	IS:2505	Concrete vibrators - immersion type.

	IS:2506	General requirements for screed board concrete vibrators.
	IS:2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
	IS:2750	Steel scaffoldings
	IS:2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
	IS:3150	Hexagonal wire netting for general purposes.
	IS:3366	Specification for pan vibrators.
	IS:3370 (Part 1-4)	Code of practice for concrete structures for the storage of liquids.
	IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
	IS:4014 (Part-1&2)	Code of practice for steel tubular scaffolding.
	IS:4326	Code of practice for earth quake resistant design and construction of buildings.
	IS:4656	Form vibrators for concrete.
	IS:4925	Concrete batching and mixing plant.
	IS:4990	Plywood for concrete shuttering work.
	IS:5256	Code of practice for sealing expansion joints in concrete lining on canals.
	IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.
	IS:6461	Glossary of terms relating to cement concrete.
	IS:6494	Code of practice for water proofing of underground reservoir and swimming pools.
	IS:6509	Code of practice for installation of joints in concrete pavements.
	IS:7861 (Part -1&2)	Code of practice for extreme weather concreting.
	IS:9012	Recommended practice for shotcreting.
	IS:9103	Admixtures for concrete.
	IS:9417	Recommendations for welding cold worked bars for reinforced concrete construction.
	IS:10262	Recommended guidelines for concrete mix design.

IS:11384	Code of practice for composite construction in structural steel and concrete.
IS:12118	Two parts polysulphide based sealants.
IS:12200	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
IS:13311	Non destructive testing of concrete - methods of test.
(Part 1)	Ultrasonic pulse velocity.
(Part 2)	Rebound hammer.
SP-16	Design codes for reinforced concrete to IS:456-1978.
SP-23	Hand book of concrete mixes.
SP-24	Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)
SP-34	Hand book on concrete reinforcement and detailing.
ACI-318	American Concrete Institute code for structural concrete.

Precast Concrete Works

SP:7 (Part 6/Sec.7)	National Building Code - Structural Design Prefabrication and system building and mixed / composite construction.
IS:10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS:10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
IS:15658	Pre-cast concrete block for paving.

Masonry & Allied Works

IS:1905	Code of practice for structural use of unreinforced masonry.
IS: 2185	Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks
IS:2212	Code of practice for brick work.
IS:2250	Code of practice for preparation and use of masonry mortars.
IS:2572	Code of practice for construction of hollow concrete block masonry.
SP:20	Hand book on masonry design and construction.

Sheeting Works

IS:277	Galvanised steel sheets (Plan & corrugated).
IS:513	Cold-rolled low carbon steel sheets & strips.
IS:730	Hook bolts for corrugated sheet roofing.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS:7178	Technical supply condition for tapping screw.
IS:8183	Bonded mineral wool.
IS:8869	Washers for corrugated sheet roofing.
IS:12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
IS:12436	Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.
IS:12866	Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).
IS:14246	Continuously pre-painted galvanised steel sheets and coils.
BS:5950	Code of practice for design of light gauge profiled
(Part-6)	steel sheeting

Fabrication and Erection of Structural Steel Works

IS:800	Code of practice for General Construction of steel.
IS:813	Scheme for symbols for welding.
IS:814	Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.
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 of metal arc welders.
IS:1024	Welding in bridges and substructured subject to dynamic.
IS:1181	Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).

	IS:1182	Recommended practice for Radiographic examination of fusion welded butt joints in steel plates
	IS:1608	Mechanical testing of metals - tensile testing
	IS:1852	Rolling and Cutting Tolerances for Hot rolled steel products.
	IS:2016	Specification for Plain washers.
	IS:2595	Code of practice for Radiographic testing
	IS:2629	Hot dip galvanising of iron and steel
	IS:3502	Steel chequred plate.
	IS:3613	Acceptance tests for wire flux combination for submerged arc welding.
	IS:3658	Code of practice for liquid penetrant flaw detection.
	IS:3664	Code of practice for ultra sonic pulse echo testing contact and immersion method
	IS:3757	High strength structural bolts.
	IS:4000	High strength bolts in steel structure - code of practice.
	IS:4353	Sub merged arc welding of mild steel and low alloy steel Recommendation
	IS:4759	Hot dip zinc coating on structural steel and other allied products.
	IS:5334	Code of practice for magnetic particle flaw detection of welds.
	IS:5369	General requirements for plain washers and lock washer
	IS : 6623	High strength structural nuts.
	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.
	IS:6911	Stainless steel plate, sheet and strip.
	IS:7205	Safety code for erection of structural steel.
	IS:7215	Tolerances for fabrication of structural steel.
	IS:7307	Approved test for welding procedures
	(Part - I)	Fusion welding of steel.
	IS:7310 (Part-I)	Approval test for welders working to approval welding procedure. Fusion welding of steel
	IS:9178 (Part-1to 3)	Criteria for design of steel bins for storage of bulk material.

	IS:9595	Recommendations for metal arc welding of carbon & carbon manganese steel.
	IS:12843	Tolerances for erection of steel structures.
	SP:6 (Part 1 to 7)	ISI Hand book for structural Engineers.
	Plastering and Allied Works	
	IS:1661	Code of practice for application of cement and cement lime plaster finishes.
	IS:2402	Code of practice for external rendered finishes.
	IS:2547 (Parts 1&2)	Gypsum building plaster.
	Acid and Alkali Resistant Lining	
	IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
	IS:412	Expanded metal steel sheets for general purpose.
	IS:4441	Code of practice for use of silica type chemical resistant mortars.
	IS:4443	Code of practice for use of resin type chemical resistant mortars.
	IS:4456 (Part I & II)	Method of Test for chemical resistant tiles.
	IS:4457	Ceramic unglazed vitreous acid resisting tiles.
	IS:4832	Specification for chemical resistant mortars.
	(Part - 1)	Silicate type
	(Part - 2)	Resin type
	(Part - 3)	Sulfur type
	IS:4860	Acid resistant bricks.
	IS:9510	Bitumastic acid resisting grade.
	Water Supply, Drainage and Sanitation	
	IS:458	Precast concrete pipes (with & without reinforcement).
	IS:554	Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
	IS:651	Salt glazed stoneware pipes and fittings.
	IS:774	Flushing cisterns for water closets and urinals.

	IS:775	Cast iron brackets and supports for wash basins and sinks.
	IS:778	Copper alloy gate, globe and check valves for water works purposes.
	IS:781	Cast copper alloy screw down bib taps & stop valves for water services.
	IS:782	Caulking lead.
	IS:783	Code of practice for laying of concrete pipes.
	IS:1172	Code of basic requirements of water supply, drainage and sanitation.
	IS:1230	Cast iron rain water pipes and fittings.
	IS:1239 (Part 1&2)	Mild Steel tubes, tubulars and other wrought steel fittings
	IS:1536	Centrifugally cast (Spun) iron pressure pipes for water.
	IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
	IS:1538	Cast iron fittings for pressure pipe for water, gas and sewage.
	IS:1703	Copper alloy float valve for water supply fitting.
	IS:1726	Cast iron manhole covers and frames.
	IS:1729	Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series.
	IS:1742	Code of practice for building drainage.
	IS:2064	Selection, installation and maintenance of sanitary appliances.
	IS:2065	Code of practice for water supply in buildings.
	IS:2326	Automatic flushing cisterns for urinals.
	IS:2548	Plastic seats and covers for water closets.
	IS:2556	Vitreous sanitary appliances (vitreous china).
	IS:3114	Code of practice for laying of cast iron pipes.
	IS:3311	Waste plug and its accessories for sinks and wash basins.
	IS:3438	Silvered glass mirrors for general purposes.
	IS:3486	Cast iron spigot and socket drain pipes.
	IS:3589	steel pipe for water and sewage (168.3 to 2540mm outside diameter)
	IS:3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS:4111 (Part 1 to 5)	Code of practice for ancillary structure in sewerage system.
IS:4127	Code of practice for laying of glazed stone ware pipes.
IS : 4733	Methods of sampling and testing sewage effluents.
IS:4764	Tolerance limits for sewage effluents discharged into inland surface waters.
IS:1068	Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
IS:5329	Code of practice for sanitary pipe work above ground for buildings.
IS:5382	Rubber sealing rings for gas mains, water mains and sewers.
IS:5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS:5961	Specification for cast iron grating for drainage purpose.
IS:7740	Code of practice for construction and maintenance of road gullies.
IS:8931	Copper alloy fancy single taps combination tap assembly and stop valves for water services.
IS:9762	Polyethylene floats for float valves.
IS:10592	Industrial emergency showers, eye and face fountains and combination units.
IS:12592	Specification for precast concrete manhole covers and frames.
IS:12701	Rotational moulded polyethylene water storage tanks.
IS:13983	Stainless steel sinks for domestic purposes.
SP:35	Hand book on water supply and drainage with special emphasis on plumbing.
CPH&EEO	Manual on sewage and sewage treatment
Publication	- as updated.

Doors Windows and Allied Works

IS:204	Tower Bolts.
(Part 1)	Ferrous metals
(Part 2)	Non - ferrous metals
IS:208	Door Handles.
IS:281	Mild steel sliding door bolts for use with padlocks.

IS:362	Parliament Hinges.
IS:419	Putty, for use on window frames.
IS:451	Technical supply conditions for wood screws
IS:733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
IS:1003 (Part I)	Timber panelled and glazed shutters (doors shutters).
IS:1003	Timber panelled and glazed shutters
(Part-1)	door shutters.
IS:1038	Steel doors, windows and ventilators.
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS:1285	Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
IS:1341	Steel butt hinges.
IS:1361	Steel windows for Industrial buildings.
IS:1823	Floor door stoppers.
IS:1868	Anodic coatings on Aluminium and its alloys.
IS:2202	Wooden flush door shutters (solid core type) particle
(Part-2)	board face panels and hard board face panels.
IS:2209	Mortice locks (vertical type)
IS:2553	Safety glass.
(Part-1)	General purposes
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated)
IS:3614	Specification for fire check doors :
(Part-1)	plate, metal covered and rolling type.
(Part-2)	Resistance test and performance criteria.

	IS:4351	Specification for steel door frames.
	IS:5187	Flush bolts.
	IS:5437	Figured, rolled and wired glass.
	IS:6248	Specification for metal rolling shutters and rolling grills.
	IS:6315	Specification for floor springs (Hydraulically regulated) for heavy doors.
	IS:7196	Hold fast.
	IS:7452	Hot rolled steel sections for doors, windows and ventilators.
	IS:10019	Mild steel stays and fasteners.
	IS:10451	Steel sliding shutters (top hung type)
	IS:12823	Prelaminated particle boards.
	Roof Water Proofing and Allied Works	
	IS:3067	code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
	ASTM	Standard specification for high solid content cold
	C836-89a	liquid applied elastomeric water proofing membrane for use with separate wearing course.
	ASTM	Standard guide for high solid content cold
	C898-89	liquid applied elastomeric water proofing membrane for use with separate wearing course.
	Floor Finishes and Allied Works	
	IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
	IS:8042	White portland cement.
	IS:13755	Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
	IS:13801	Chequered cement concrete tiles.
	Painting and Allied Works	
	IS:162	Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
	IS:428	Distemper, oil, emulsion, colour as required.
	IS:1477	Code of practice for painting of terrous metals in buildings.

(Part -1)	Pretreatment.
(Part -2)	Painting.
IS:1650	Specification for colours for building and decorative materials.
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
IS:2338	Code of practice for finishing of wood and wood based materials.
(Part -1)	Operations and Workmanship.
(Part -2)	Schedule.
IS:2395	Code of pratice for painting concrete, masonry and plaster surfaces.
(Part-1)	Operations and Workmanship.
(Part -2)	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
(Part -1)	Pretreatment
(Part -2)	Painting.
IS:2932	Enamel, synthetic, exterior, (a) under coating and (b) finishing.
IS:2933	Enamel exterior, (a) under coating, (b) finishing.
IS:4759	Hot dip zinc coatings on structural steel and other allied products.
IS:5410	Specification for cement paint.
IS:15489	Plastic emulsion paint.
IS:6278	Code of practice for white washing and Colour washing.
IS:10403	Glossary of term related to building finish.
IS:12027	Silicone based water repellent
IS:13238	Epoxy based zinc phosphate primer (2 pack)
IS:13239	Epoxy surfacer (2 pack)
IS:13467	Chlorinated rubber for paints
IS:14209	Epoxy enamel, two component glossy.
BS:5493	Code of practice for protective coating of iron and steel structures against corrosion.

Piling and Foundation

IS:1080	Code of practice for design and construction of shallow foundations on soils.
IS:1904	Code of practice for design and construction of foundation in Soils : General Requirements.
IS:2314	Steel sheet piling sections.
IS:2911	Code of practice for design and construction of pile foundations. (Relevant Parts)
IS:2950	Code of practice for designs and construction of Raft foundation.
(Part-1)	Design
IS:2974 (Part-1 to 5)	Code of practice for design and construction of machine foundation.
IS:4091	Code of practice for design and construction foundations for transmission line towers and poles.
IS:6403	Code of practice for determination of Bearing capacity of Shallow foundations.
IS:8009	Code of practice for calculation of settlement of foundation.
(Part -1)	Shallow foundations.
(Part -2)	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
ISO 10816	Criteria for assessing mechanical vibrations of machines.
ISO 1940	Criteria for assessing the st of balance of rotating rigid bodies.
DIN : EN 13906-1	Helical compression spring made of round wire and rod : calculation and design of compression .
DIN:2096	Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.
DIN:4024	Flexible supporting structures for machine with rotating machines.

Roads

IRC:5 (Section-1)	Standard specifications and Code of practice for road bridges, General Features of Design.
IRC:14	Recommended practice for 2cm thick bitumen and tar carpets.

	IRC:15	Standard specifications and code of practice for construction of concrete roads.
	IRC:16	Specification for priming of base course with bituminous primers.
	IRC:19	Standard specifications and Code of practice for water bound macadam.
	IRC:21 (Section-III)	Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).
	IRC:34	Recommendations for road construction in water logged areas.
	IRC:36	Recommended practice for the construction of earth embankments for road works.
	IRC:37	Guidelines for the Design of flexible pavements.
	IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
	IRC:58	Guidelines for the design of rigid pavements for highways.
	IRC:73	Geometric Design standards for rural (non-urban) highways.
	IRC : 86	Geometric Design standards for urban roads in plains.
	IRC:SP:13	Guidelines for the design of small bridges & culverts.
	IRC - Publication	Ministry of Surface Transport (Road wing), specifications for road and bridge works.
	IS:73	Paving bitumen.
	Loading	
	IS:875	Code of practice for design loads (other than earthquake) for (Relevant parts) buildings and structures.
	IS:1893	Criteria for earthquake resistant design of structures.
	IS:4091	Code of practice for design and construction of foundation for transmission line towers and poles.
	IRC:6 (Section-II)	Standard specifications & Code of practice for road bridges. loads and stresses
	Safety	
	IS:1641	Code of practice for fire safety of buildings - General principles of fire grading and classification.
	IS:1642	Code of practice for fire safety of buildings - Details of construction.
	IS:3696	Safety code for scaffolds and ladders.

(Part-1&2)

IS:3764	Excavation work - code of safety.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Demolition of buildings - code of safety.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection of structural steel work.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials.
Indian Explosives Act 1940)	(As updated)

Architectural Design of Buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)
ECBC	Energy Conservation Building Code
GRIHA	Green Rating For Integrated Habitat Assessment.

Chimney

IS:4998	Criteria for design of reinforced chimneys
IS:6533	Code of practice for design and construction of steel chimneys
ICAO	International Civil Aviation Organisation (ICAO)
DGCA	Instruction of Director General of Civil Aviation , India
ACI:307	Specification for the design and construction of reinforced concrete chimneys
BS:4076	Specification for steel chimneys
CICIND	Model Code for concrete chimneys Model code for steel chimneys
ASCE Code	Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975.
IS:1554	PVC insulated (heavy duty) electric cables
IS:2606	Alloy lead anodes for chromium plating

IS:3043	Code of Practice for Earthing
IS:9537	Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act
IS:2309	Practice for protection of buildings and allied structures against lightning

Miscellaneous

IS:802 (Relevant parts)	Code of practice for use of structural steel in overhead trans-mission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and guidance for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
IS 11504	Criteria for structural design of reinforced concrete natural draught cooling towers
BS:4485 (IV)	British Standard : Code of design for water cooling towers
CIRIA Publication	Design and construction of buried thin-wall pipes.
IS 4671	Expanded polystyrene for thermal insulation purposes.

ANNEXURE (b)

CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanised from the start of the work.

All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydaulically controlled grouting equipment.

Roadwork shall be done using pavers, rollers and premix plant.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

ANNEXURE (c)

ARKITECHNO — **ArkiTechno Consultants (India) Pvt. Ltd**

N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.
Bore Hole No : BH-20
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)

Coordinate: E- 335938.000 N- 2611483
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water level EGL (in m) : 1.00
Date of commencement : 08.01.2016
Date of Completion : 10.01.2016
Conducted By : Jitendra Kumar Sahu

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No.of Pieces	Details of Rock Core Length of core greater Than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Clayey Silt		1.00	SPT	2	4	5	9						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Collected
2.50	4.00	1.50	Soft (or D) mok		4.00	SPT	78	100		N>100. 7cm Penetration						Sample Collected
4.00	5.50	1.50			5.50	SPT	100			N>100. 4cm Penetration						Sample not Collected
5.50	7.00	1.50			7.00	SPT	100			N>100. 2cm Penetration						Sample Collected
7.00	8.50	1.50			8.50	SPT	100			N>100. 4cm Penetration						Sample Collected
8.50	10.00	1.50			10.00	SPT	100			N>100. 2cm Penetration	15	3	10			Sample Collected
10.00	11.50	1.50			11.50	SPT	100			N>100	18	8	12			Sample Collected
11.50	13.00	1.50			13.00	SPT	100			N>100. 2cm Penetration	25	3	17			Sample Collected
13.00	14.50	1.50	Sand Stone		14.50	SPT	100			N>100. 1cm Penetration	44	9	28			Sample Collected
14.50	16.00	1.50			16.00	Double Tube Core Barrel Used					34	5	22			Sample Collected

ARKITECHNO — **ArkiTechno Consultants (India) Pvt. Ltd**

N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS,Jharkhand.
Bore Hole No : BH-20
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split-Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)

Coordinate E- 329939.000 N- 2616463
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water from EGL (in m) : 1.00
Date of commencement : 08.01.2016
Date of Completion : 10.01.2016
Conducted By : Jitendra Kumar Sahu

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth			N value					
From	To	Length of Run (m)			Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm		Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.50	17.50	1.50	Sand Stone		17.50		Double Tube Core Barrel Used				35	9		23		Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used				27	4	11	18	7	Sample Collected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used				13	3		9		Sample Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used				32	6	13	21	9	Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used				48	6	15	32	10	Sample Collected
23.50	25.00	1.50			25.00	SPT	100			N>100	45	18		30		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinates: E- 325044 N- 2916324

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m): Refer Topographical survey

Bore Hole No : BH-42 — Depth of Ground Water from EGL (in m) : 4.50

Location : Main Plant — Date of commencement : 02.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 07.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) ,75mm in rock (Double Tube Core Barrel) — Conducted By : Rajaram Salvo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core					Remarks
					Depth	Type	Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
From	To						0 - 15 cm	15 - 30 cm	30 - 45 cm						
0.00	1.00	1.00	Alluvium		1.00	SPT	20	22	25	47					Sample Coleted
1.00	2.50	1.50			2.50	UCS									UDS Failed
2.50	4.00	1.50			4.00	SPT	23	24	28	50					Sample Coleted
4.00	5.50	1.50	Ferruginous Sand		5.50	SPT	100	N > 100, 3cm Penetration		Double Tube Core Barrel Used					Smal pieces collected
5.50	7.00	1.50			7.00					Double Tube Core Barrel Used					Smal pieces collected
7.00	8.50	1.50	Carbonized clay		8.50	SPT	11	12	14	26					Sample Coleted
8.50	10.00	1.50			10.00	SPT	13	10	9	19					Sample Coleted
10.00	11.50	1.50	Coal		11.50	SPT	100	N > 100, 2cm Penetration		Double Tube Core Barrel Used					Smal pieces collected
11.50	13.00	1.50	Rock		13.00		Double Tube Core Barrel Used			26	12		17		Sample Coleted
13.00	14.50	1.50			14.50		Double Tube Core Barrel Used			44	11	30.10	39	20	Sample Coleted
14.50	16.00	1.50			16.00		Double Tube Core Barrel Used			54	7	23.11	36	23	Sample Coleted

ARKITECHNO — **ArkiTechno Consultants (India) Pvt. Ltd**

N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinate : E- 326044 N- 2613324

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No. : BH-42 — Depth of Ground Water from EGL (in m) : 4.50

Location : Main Plant — Date of commencement : 02.01.2018

Type of Boring : Rotary Drilling — Date of Completion : 07.01.2018

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Rajaram Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
							Blows Required for Penetration of depth							
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of pore greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.00	17.50	1.50	Rock		17.90		Double Tube Core Barrel Used				54	3	23, 19, 11	36	35	Sample Collected
17.50	19.00	1.50			19.90		Double Tube Core Barrel Used				30	5		20		Sample Collected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used				29	3		19		Sample Collected
20.50	22.00	1.50	Sand Stone		22.90		Double Tube Core Barrel Used				37	7		25		Sample Collected
22.00	23.50	1.50			23.90		Double Tube Core Barrel Used				40	7		27		Sample Collected
23.50	25.00	1.50	Soft to Dy rock		25.90		Double Tube Core Barrel Used				32	4	14, 11	21	17	Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC

Coordinate E- 329725.307 N- 2616196.376

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. Existing Ground Level (m) Refer Topographical survey

Bore Hole No. : BH-1 Depth of Ground Water from EGL (in m) : 6.04

Location : Main Plant Date of commencement : 01.11.2015

Type of Boring : Rotary Drilling Date of Completion : 10.11.2015

Dia ofBore/ Samper : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) Conducted by : B. R. Pattnayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
							Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm						
0.00	1.00	1.00	Mowrum With Clay		1.00	SPT	2	3	4	7					Sample Collected
1.00	2.50	1.50			2.50	UDS									Sample Collected
2.50	4.00	1.50			4.00	SPT	SPT Rebounded, N>100, 4cm Penetration								Sample not Collected
4.00	5.50	1.50	Weathered Sand Stone		5.50					27	8		14		Sample Collected
5.50	7.00	1.50	Soft (or DI) rock		7.00					30	8		20		Sample Collected
7.00	8.50	1.50	Soft rock (black colour)		8.50										Sample not Collected
8.50	10.00	1.50	Carbonaceous Clay		10.00					43	9		29		Sample Collected
10.00	11.50	1.50	Sedimentary Rock with Coal		11.50	SPT	SPT Rebounded, N 100, 4cm Penetration								Sample Collected
11.50	13.50	2.00			13.50	SPT	SPT Rebounded, N 100, 3cm Penetration								Sample Collected
13.50	15.00	1.50			15.00	SPT	SPT Rebounded, N 100, 2cm Penetration			45	19		30		Sample Collected
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used			146	21	14, 17	97	21	Sample Collected
16.50	18.00	1.50			18.00		Double Tube Core Barrel Used			148	11	15,20,13,15, 16,17,13	99	73	Sample Collected
18.00	19.50	1.50			19.50		Double Tube Core Barrel Used			117	12	17,17,17,10	78	41	Sample Collected

ARKITECHNO — **ArkiTechno Consultants (India) Pvt. Ltd**

N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand
Bore Hole No. : BH-1
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil /Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)

Coordinate: E- 325725.307 N- 2616196.376 Refer Topographical survey
Elvsing Ground Level (m) :
Depth of Ground Water from EGL (in m) : 6.04
Date of commencement : 01.11.2015
Date of Completion : 10.11.2015
Conducted By : B. R. Pathayak

Depth(m)				Sampling		SPT			Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm / 15 - 30 cm / 30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
19.50	21.00	1.50	Sedimentary Rock with Coal		21.00		Double Tube Core Barrel Used		137	13	14, 15, 24, 13	91	44	Sample Colected
21.00	22.00	1.00			22.00		Double Tube Core Barrel Used		73	13	15	73	15	Sample Colected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinate : E- 366633 N- 2516372

Projec : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore hole No. : BH-40 — Depth of Ground Water from EGL (in m) : 1.50

Location : Main Plant — Date of commencement : 30.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 02.01.206

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted By : Rajaram Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core					Remarks
							Blows Required for Penetration of depth								
From	To				Depth	Type	0- 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater then 10cm	% of Core Recovery	RQD Value (%)	
0.00	1.00	1.00	Clay Soil		1.00	SPT	10	11	13	24						Sample Collected
1.00	2.50	1.50			2.50	UDS										Sample Collected
2.50	4.00	1.50	Moram		4.00	SPT	9	14	16	30						Sample Collected
4.00	5.50	1.50			5.50	UDS										Sample not Collected
5.50	7.00	1.50	Soft (or DI) rock		7.00	SPT	100	N > 100, 2cm Penetration								Sample Collected
7.00	8.50	1.50	Clayey Soil		8.50	SPT	6	7	10	17						Sample Collected
8.50	10.00	1.50			10.00	SPT	6	9	12	21						Sample Collected
10.00	11.50	1.50			11.50	SPT	7	10	13	23						Sample Collected
11.50	13.00	1.50	Carbonize Clay		13.00	SPT	10	9	11	20						Sample Collected
13.00	14.50	1.50			14.50	SPT	11	9	11	20						Sample Collected
14.50	16.50	2.00			16.50	SPT	13	10	12	22						Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : **NTPC** Coordinate: E- 325833 N- 2618372

Project : **Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.** Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : **BH-40** Depth of Ground Water from EGL (in m) : 1.50

Location : Main Plant Date of commencement : 30.12.2015

Type of Boring : Rotary Drilling Date of Completion : 02.01.206

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) Conducted By : Rajaram Sahoo

Depth (m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth			N value					
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm		Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.50	17.50	1.00	Coal		17.50	SPT	100		N > 100		30	6		30		Sample Collected
17.50	19.50	2.00			19.50		Double Tube Core Barrel Used				24	6		12		Sample Collected
19.50	20.00	0.50			20.00		Double Tube Core Barrel Used				21	5		42		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand

Bore Hole No : BH-41

Location : Main Plant

Type of Boring : Rotary Drilling

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel)

Coordinate : E- 325480 N- 2616083

Existing Ground Level (m) : Refer Topographical survey

Depth of Ground Water from ESL (in m) : 3.10

Date of commencement : 25.01.2016

Date of Completion : 27.01.2016

Conducted By : B. R. patnayak

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Reddish Clay		1.00	SPT	7	9	7	16						Sample Collected
1.00	2.50	1.50			2.50	UDS										Sample not Collected
2.50	4.00	1.50	Sand		4.00	SPT	9	7	6	13						Sample Collected
4.00	5.50	1.50			5.50	SPT	11	8	6	14						Sample Collected
5.50	7.00	1.50			7.00	SPT	18	16	27	43						Sample Collected
7.00	8.50	1.50			8.50	SPT	29	43	65	108						Sample Collected
8.50	10.00	1.50			10.00	SPT	42	63	100	163						Sample Collected
10.00	11.50	1.50	Sand stone		11.50	SPT	100	N > 100 1cm Penetration			15	5		10		Sample Collected
11.50	13.00	1.50			13.30		Double Tube Core Barrel Used				42	4	14, 12	28	17	Sample Collected
13.00	14.50	1.50			14.50		Double Tube Core Barrel Used				54	6	12,13	36	17	Sample Collected
14.50	16.00	1.50			16.30		Double Tube Core Barrel Used				40	3	16, 11	27	19	Sample Collected

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H 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 326880	N- 2618093
Projec:	:	Geotechnical investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical survey
Bore Hole No.	:	BH-41	Depth of Ground Water from EGL (in m)	:	3.10
Location	:	Main Plant	Date of commencement	:	25.01.2016
Type of Boring	:	Rotary Drilling	Date of Completion	:	27.01.2016
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	:	B. R pathayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
							Blows Required for Penetration of depth							
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N Value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.00	17.50	1.50	Sand stone		17.50		Double Tube Core Barrel Used				48	6	15.12	32	18	Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used				46	7	13.10	31	15	Sample Collected
19.00	20.00	1.00			20.00		Double Tube Core Barrel Used				35	4	12	35	12	Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand
Bore Hole No. : BH-2
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)

Coordinate: E- 325692.657 N- 2615358.399
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water from EGL (in m) : 6.00
Date of commencement : 28.10.2015
Date of completion : 02.11.2015
Conducted By : B. R. Pattnayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Sand With Gravel		1.00	SPT	20	57	Rebounded, N>100, 2cm Penetration							Sample Collected
1.00	4.50	3.50			4.50	SPT	46	Rebounded, N>100, 5cm Penetration								Sample Collected
4.50	7.50	3.00			7.50	SPT	SPT Rebounded, N>100									Sample not Collected
7.50	9.00	1.50	Granite Gneiss		9.00		Double Tube Core Barrel Used			150	18	12,14,10,28	100	43	Sample Collected
9.00	10.50	1.50			10.50		Double Tube Core Barrel Used			145	14	16, 17, 15, 10, 13	97	47	Sample Collected
10.50	12.00	1.50			12.00		Double Tube Core Barrel Used			87	15	10	58	7	Sample Collected
12.00	13.50	1.50			13.50		Double Tube Core Barrel Used			35	5	10,13	23	15	Sample Collected
13.50	15.00	1.50			15.00		Double Tube Core Barrel Used			114	17	11,10	76	14	Sample Collected
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used			122	15	13,12,11	81	24	Sample Collected
16.50	18.00	1.50			18.00		Double Tube Core Barrel Used			126	14	18,17,11	84	31	Sample Collected

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ArkiTechno Consultants (India) Pvt. Ltd

N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.

Bore Hole No. : BH-3

Location : Main Plant

Type of Boring : Rotary Drilling

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)

Coordinate: E- 325992.635 N- 2618060.244

Existing Ground Level (m) : Refer Topographical survey

Depth of Ground Water from EGL (in m) : Couldn't measured due to water lose

Date of commencement : 14.10.2015

Date of Completion : 22.10.2015

Conducted By : Binayak Swain

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No. of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Clay with Sand		1.00	SPT	3	5	5	10						Sample Collected
1.00	2.50	1.50	Sandy Clay		2.50	UDS										Sample Collected
2.50	4.00	1.50	Fine Sand		4.00	SPT	23	23	27	50						Sample Collected
4.00	5.50	1.50			5.50	UDS										UDS Failed
5.50	7.00	1.50	Soft sand Stone		7.00	SPT	52	62	67	129						Sample Collected
7.00	10.00	3.00			10.00	SPT	100	N>100, SPT Rebounded, 7cm Penetration								Sample Collected
10.00	13.00	3.00			13.00	SPT	57	100	Rebounded, N>100 6cm Penetration							Sample Collected
13.00	14.50	1.50	Sand Stone		14.50	Double Tube Core Barrel Used										Small pieces Collected
14.50	16.00	1.50			16.00	Double Tube Core Barrel Used					47	14		31		Sample Collected
16.00	17.50	1.50			17.50	Double Tube Core Barrel Used					33	9		22		Sample Collected
17.50	19.00	1.50			19.00	Double Tube Core Barrel Used					39	9		26		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand
Bore Hole No : BH-3
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel)

Coordinate : E- 325892.635 N- 2616060.234
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water from EGL (in m) : Couldn't measured due to water lose
Date of commencement : 14.10.2015
Date of Completion : 22.10.2015
Conducted By : Binayak Swain

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N Value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
19.00	20.50	1.50	Soft (or Dil) Rock		20.50		Double Tube Core Barrel Used				75	10	18	80	12	Sample Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used				72	9	10,10,10	48	20	Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used				90	13		60		Sample Collected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used				74	11	11	49	7	Sample Collected
25.00	26.50	1.50	Granite Gneiss		26.50		Double Tube Core Barrel Used				94	15	10	63	7	Sample Collected
26.50	28.00	1.50			28.00		Double Tube Core Barrel Used				150	14	14,12,13,10, 28,11,17	100	39	Sample Collected
28.00	29.00	1.00			29.00		Double Tube Core Barrel Used				83	6	20,28,11	85	57	Sample Collected
29.00	30.00	1.00			30.00		Double Tube Core Barrel Used									Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 1254862.3 N- 2816154.272

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS,Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-4 — Depth of Ground Water from EG. (in m) : 3.00

Location : Main Plant — Date of commencement : 05.10.2015

Type of Boring : Rotary Drilling — Date of Completion : 16.10.2015

Dia of Bore/ Sampler : 150mm (Soil (Split Spoon Sampler) , 75mm in rock(Double Tube Core Barrel) — Conducted By : Binayak Swain

Depth(m)					Sampling		SPT				Details of Rock Core					
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0- 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Clay with Moorum		1.00	SPT	5	10	11	21						Sample Collected
1.00	3.00	2.00			3.00	SPT	7	11	14	25						Sample Collected
3.00	4.50	1.50	Hard Silty Soil		4.50	SPT	8	20	52	72						Sample Collected
4.50	6.00	1.50			6.00	SPT	17	39	46	85						Sample Collected
6.00	6.50	0.50			6.50	SPT	100	SPT Rebounded at 100 blows, 3cm penetration								Sample Collected
6.50	7.50	1.00	Sand Stone		7.50		Double Tube Core Barrel Used				80	15		80		Sample Collected
7.50	8.50	1.00			8.50		Double Tube Core Barrel Used				56	8	13	56	13	Sample Collected
8.50	9.50	1.00	Soft or Dil rock		9.50		Double Tube Core Barrel Used				54	7	10, 15	54	25	Sample Collected
9.50	10.50	1.00			10.50		Double Tube Core Barrel Used				40	6	15	40	15	Sample Collected
10.50	11.50	1.00			11.50		Double Tube Core Barrel Used				53	9	12	53	12	Sample Collected
11.50	13.00	1.50			13.00		Double Tube Core Barrel Used				49	8		33		Sample Collected
13.00	14.50	1.50			14.50		Double Tube Core Barrel Used				46	5	12, 15	31	20	Sample Collected
14.50	16.00	1.50			16.00		Double Tube Core Barrel Used				95	9	10, 16, 9, 12, 11	64	45	Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E 325486.273	N 2616154.272
Project	:	Geotechnical investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)	:	Refer Topographical survey
Bore Hole No.	:	BH-4	Depth of Ground Water from EGL (in m)	:	3.00
Location	:	Main Plant	Date of commencement	:	05.10.2015
Type of Boring	:	Rotary Drilling	Date of Completion	:	16.10.2015
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) & 75mm in rock (Double Tube Core Barrel).	Conducted By	:	Binayak Swain

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core					Remarks
From	To	Length of Run (m)			Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
16.00	17.50	1.50	Sedimentary Rock with Coal		17.50		Double Tube Core Barrel Used				100	6	18, 33, 27, 12	87	60	Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used				80	10	10	53	7	Sample Collected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used				94	15		63		Sample Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used				140	18	3,12,10	93	23	Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used				66	8	14, 13	44	18	Sample Collected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used									Small pieces collected
25.00	26.50	1.50			26.50		Double Tube Core Barrel Used				122	18	14 13, 14	81	27	Sample Collected
26.50	28.00	1.50			28.00		Double Tube Core Barrel Used				142	19	10, 21, 14, 13	95	39	Sample Collected
28.00	29.50	1.50			29.50		Double Tube Core Barrel Used				111	11	21, 13, 14	74	32	Sample Collected
29.50	30.00	0.50			30.00		Double Tube Core Barrel Used									Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 386656.446 N- 2515619.086

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No. : BH-5 — Depth of Ground Water from EGL (in m) : Couldn't measured due to water lose

Location : Main Plant — Date of commencement : 20.11.2015

Type of Boring : Rotary Drilling — Date of Completion : 28.11.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 76mm in rock(Double Tube Core Barrel) — Conducted By : T. K. Das

Depth (m) From	Depth (m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 – 15 cm	SPT Blows Required for Penetration of depth 15 – 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Silty sand with Gravel		1.00	SPT	6	12	22	34						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Silty sand		4.00	SPT	19	48	54	102						Sample Collected
4.00	7.00	3.00	Sand with Gravel		7.00	SPT	100	SPT Rebounded, N>100, 3cm penetration								Sample not Collected
7.00	8.50	1.50	Soft (or Dil) rock		8.50		Double Tube Core Barrel Used				27	5		19		Sample Collected
8.50	9.00	0.50			9.00	SPT	100	SPT Rebounded, N>100, 2cm penetration								Sample not Collected
9.00	10.50	1.50			10.50		Double Tube Core Barrel Used									Small pieces Collected
10.50	12.00	1.50			12.00		Double Tube Core Barrel Used				34	5	11	23	7	Sample Collected
12.00	13.50	1.50	Rock		13.50		Double Tube Core Barrel Used				85	7	18	57	1	Sample Collected
13.50	15.00	1.50			15.00		Double Tube Core Barrel Used				57	10		38		Sample Collected
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used				47	5	16.19	31	21	Sample Collected
16.50	18.00	1.50			18.00		Double Tube Core Barrel Used				57	8	10.14	38	18	Sample Collected
18.00	19.50	1.50			19.50		Double Tube Core Barrel Used				107	16	12.15	71	18	Sample Collected

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BORE LOG DETAILS

Client : NTPC

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.

Bore Hole No : BH-6

Location : Main Plant

Type of Boring : Rotary Drilling

Dia of Bore/ Sampler : 150mm in soil / Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel)

Coordinate : E- 325669.448 N- 2615919.068

Existing Ground Level(m) : Refer Topographical survey

Depth of Ground Water from EGL (in m) : Couldn't measured due to water lose

Date of commencement : 20.11.2015

Date of Completion : 28.11.2015

Conducted By : T. K. Das

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm / 15 - 30 cm / 30 - 45 cm	N Value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
19.50	21.00	1.50	Rock		21.00		Double Tube Core Barrel Used		140	10	19, 55,15,19	93	66	Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used		76	11	16, 17	51	22	Sample Collected
22.50	24.00	1.50	Soft (or Dl) rock		24.00		Double Tube Core Barrel Used		14	3		9		Sample Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used		27	5		18		Sample Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used		24	4		16		Sample Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used		35	4	13,10	23	15	Sample Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used		49	6	13,10	33	15	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325948.708 N+2613014.999

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at NTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-6 — Depth of Ground Water from EGL (in m) : 8.50

Location : Main Plant — Date of commencement : 09.11.2015

Type of Boring : Rotary Drilling — Date of Completion : 21.11.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted By : T. K. Das

Depth (m) From	Depth (m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Cayey Silt		1.00	SPT	4	5	11	16						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Clayey Silt with Gravel		4.00	SPT	7	11	13	24						Sample Collected
4.00	5.50	1.50			5.50	SPT	10	SPT Rebounded, N>100, 3cm penetration								Sample not Collected
5.50	7.00	1.50	Soft (or D) rock		7.00		Double Tube Core Barrel Used									Small pieces Collected
7.00	8.00	1.00			8.00		Double Tube Core Barrel Used									Small pieces Collected
8.00	9.50	1.50			9.50		Double Tube Core Barrel Used				46	8		31		Sample Collected
9.50	11.00	1.50	Rock		11.00		Double Tube Core Barrel Used				71	11	10	47	7	Sample Collected
11.00	12.50	1.50			12.50		Double Tube Core Barrel Used				95	12	10, 15	63	15	Sample Collected
12.50	14.00	1.50			14.00		Double Tube Core Barrel Used				117	17	12,15	78	17	Sample Collected
14.00	15.50	1.50	Soft (or D) rock		15.50		Double Tube Core Barrel Used				42	7		28		Sample Collected
15.50	17.00	1.50			17.00		Double Tube Core Barrel Used				77	15		51		Sample Collected
17.00	18.50	1.50			18.50		Double Tube Core Barrel Used				87	23		58		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 325549.709	N- 2916014.996
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical Survey
Bore Hole No.	:	BH-6	Depth of Ground Water from EGL (in m)	:	6.50
Location	:	Main Plant	Date of commencement	:	09.11.2015
Type of Boring	:	Rotary Drilling	Date of Completion	:	21.11.2015
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	:	T. K. Das

Depth(m)				Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
From	To	Length of Run (m)	Description of Strata		Depth	Type	Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
							0 - 15 cm	15 - 30 cm	30 - 45 cm						
18.50	20.00	1.50	Soft (or Cl) rock		20.00		Double Tube Core Barrel Used			30	7		20		Sample Collected
20.00	21.50	1.50			21.50		Double Tube Core Barrel Used			42	7	14	28	9	Sample Collected
21.50	23.00	1.50			23.00		Double Tube Core Barrel Used			79	14	11	53	7	Sample Collected
23.00	24.50	1.50			24.50		Double Tube Core Barrel Used			60	9	19	40	13	Sample Collected
24.50	26.00	1.50			26.00		Double Tube Core Barrel Used								Small pieces Collected
26.00	27.50	1.50			27.50		Double Tube Core Barrel Used			39	9		26		Sample Collected
27.50	29.00	1.50			29.00		Double Tube Core Barrel Used			44	7		29		Sample Collected
29.00	30.00	1.00	Rock		30.00		Double Tube Core Barrel Used			60	10	11	60	11	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 835434.940 N- 2618118.827

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : EH-7 — Depth of Ground Water from EGl (in m) : 1.00

Location : Main Plant — Date of commencement : 25.09.2015

Type of Boring : Rotary Drilling — Date of Completion : 01.10.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) / 75mm in rock (Double Tube Core Barrel) — Conducted By : B. R. Patrayak

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
From	To	Length of Run (m)			Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.50	1.50	Morrum with clay		1.00	SPT	10	9	11	20						Sample Collected
1.50	3.00	1.50			3.00	SPT	20	30	50	80						Sample Collected
3.00	4.50	1.50			4.50	SPT	24	38	68	106						Sample Collected
4.50	6.00	1.50			6.00	SPT	SPT rebounded at 100 blows. 8cm penetrated									Sample Collected
6.00	7.50	1.50			7.50	SPT	SPT rebounded at 100 blows. 11cm penetrated									Sample Collected
7.50	9.00	1.50	Silty Clay		9.00	SPT	SPT rebounded at 100 blows. 10cm penetrated									Sample Collected
9.00	10.50	1.50			10.50	SPT	SPT rebounded at 100 blows. 7cm penetrated									Sample Collected
10.50	12.00	1.50			12.00	SPT	SPT rebounded at 100 blows. 12cm penetrated									Sample Collected
12.00	13.50	1.50			13.50	SPT	SPT rebounded at 100 blows. 11cm penetrated									Sample Collected
13.50	15.00	1.50			15.00	SPT	SPT rebounded at 100 blows. 9cm penetrated									Sample Collected
15.00	15.50	0.50			15.50	SPT	SPT rebounded at 100 blows. 20cm penetrated									Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335434.880 (N- 2616118.827

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH7 — Depth of Ground Water from EGL (in m) : 1.00

Location : Main Plant — Date of commencement : 25.09.2015

Type of Boring : Rotary Drilling — Date of Completion : 01.10.2015

Dia of Bore/ Sampler : 165mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : B. R. Pathayak

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N Value	Details of Rock Core Total Length (cm)	Details of Rock Core No.of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
15.50	17.00	1.50	Sand Stone		17.00						81	9	12, 12, 13	54	25	Sample Colleded
17.00	18.50	1.50			18.50											Small Pieces Colleded
18.50	19.50	1.00	Silty Clay		19.50	SPT	SPT rebounded at 100 blows 10cm penetrated									Sample Colleded
19.50	21.00	1.50			21.00	SPT	SPT rebounded at 100 blows 12cm penetrated									Sample Colleded
21.00	22.50	1.50			22.50	SPT	SPT rebounded at 100 blows 13cm penetrated									Sample Colleded
22.50	24.00	1.50			24.00	SPT	SPT rebounded at 100 blows 12cm penetrated									Sample Colleded
24.00	25.50	1.50	Soft / Dri rock		25.50	SPT	SPT rebounded at 100 blows 2cm penetrated									Sample Colleded
25.50	27.00	1.50			27.00											Sample not Colleded
27.00	28.50	1.50			28.50											Sample not Colleded
28.50	30.00	1.50			30.00											Sample not Colleded

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335693.842 N- 2615821.378

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-8 — Depth of Ground Water from EGL (in m) : 6.00

Location : Main Plant — Date of commencement : 08.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 12.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Jena

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth								
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Clayey Soil		1.00	SPT	9	8	10	18						Sample Collected
1.00	2.50	1.50	Silty Sand		2.40	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	32	100		N >100						Sample Collected
4.00	5.50	1.50			5.40	SPT	61	100		N >100						Sample Collected
5.50	7.00	1.50			7.00	SPT	100			N >100						Sample not Collected
7.00	8.50	1.50	Soft (or Dly rock		8.40	Double Tube Core Barrel Used										Small pieces Collected
8.50	10.00	1.50			10.00	Double Tube Core Barrel Used				13	3		9			Sample Collected
10.00	11.50	1.50	Soft (or Dly rock (non Coring)		11.50	Double Tube Core Barrel Used										Sample not Collected
11.50	13.00	1.50			13.00	SPT	100									Sample not Collected
13.00	14.50	1.50	Soft (or Dly rock		14.50	Double Tube Core Barrel Used										Small pieces Collected
14.50	16.00	1.50			16.00	Double Tube Core Barrel Used				28	6		19			Sample Collected
16.00	17.50	1.50	Soft (or Dly rock (non Coring)		17.50	Double Tube Core Barrel Used										Sample not Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 326859.845 N- 2615821378

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jhaktrans — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-8 — Depth of Ground Water from EGL (in m) : 6.80

Location : Main Plant — Date of commencement : 08.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 12.12.2015

Dia of Bore/ Sampler : 150mm in soil /Split Spoon Samplers , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Jena

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
17.50	19.00	1.50	Soft (or D) rock		19.00		Double Tube Core Barrel Used				12	3		8		Sample Collected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used									Small peces Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used				13	3		9		Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used				18	4		12		Sample Collected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used				22	5		15		Sample Collected
25.00	26.50	1.50			26.50		Double Tube Core Barrel Used				34	7		23		Sample Collected
26.50	28.00	1.50			28.00		Double Tube Core Barrel Used									Small peces Collected
28.00	28.50	0.50			28.50		Double Tube Core Barrel Used				19			38		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325552.27' N- 2615918.515

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No. : BH-9 — Depth of Ground Water from EGL (in m) : 7.20

Location : Main Plant — Date of commencement : 22.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 26.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted By : T. K. Das

Depth(m)						Sampling		SPT			Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Gravel with Clay		1.00	SPT	6	12	16	28						Sample Collected
1.00	2.50	1.50			2.50	UDS										Sample Collected
2.50	4.00	1.50	Clayey Silt		4.00	SPT	62	27	46	73						Sample Collected
4.00	5.50	1.50			5.50	UDS										UDS Failed
5.50	7.00	1.50			7.00	SPT	41	100	N >100 7cm Penetration							Sample Collected
7.00	8.50	1.50	Soft (or DI) rock		8.50	SPT	100		N >100, 4cm Penetration							Small pieces collected
8.50	10.00	1.50			10.00	SPT	100		N >100, 3cm Penetration							Small pieces collected
10.00	12.00	2.00			12.00		Double Tube Core Barrel Used				47	5		24		Sample Collected
12.00	13.50	1.50			13.50		Double Tube Core Barrel Used				48	11		32		Sample Collected
13.50	15.00	1.50			15.00	SPT	100		N >100, 4cm Penetration							Small pieces collected
15.00	16.50	1.50	Soft (or DI) rock (Non-coring)		16.00	SPT	100		N >100, 3cm Penetration							Sample Not Collected
16.50	18.00	1.50	Soft (or DI) rock		18.00	SPT	100		N >100, 2cm Penetration							Small pieces collected

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BCRE LOG DETAILS

Client : **NTPC** Coordinate E- 325435.271 N- 2615618.615

Project : **Geotechnical investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.** Existing Ground Level (m) Refer Topographical survey

Bore Hole No. : BH-B Depth of Ground Water from EGL (in m) : 7.20

Location : Main Plant Date of commencement : 22.12.2015

Type of Boring : Rotary Drilling. Date of Completion : 26.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 76mm in rock (Double Tube Core Barrel) Conducted By : T. K. Das

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
18.00	19.50	1.50	Soft (or DI) rock		19.50		Double Tube Core Barrel Used				93	14	13, 10, 16, 10, 14	62	38	Sample Collected
19.50	21.00	1.50			21.00		Double Tube Core Barrel Used				83	18		55		Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used				34	8		23		Sample Collected
22.50	24.00	1.50			24.00		Double Tube Core Barrel Used				105	19		70		Sample Collected
24.00	25.50	1.50	Rock		25.50		Double Tube Core Barrel Used				142	16	27, 10, 24, 11, 13	95	57	Sample Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used				139	11	34, 19, 14, 11, 13, 12, 11	93	76	Sample Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used				148	8	19, 60, 25, 33	99	91	Sample Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used				115	8	20, 57	77	51	Sample Collected

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BORE LOG DETAILS

Client	: NTPC	Coordinate	: E- 325361.629	N- 2616027.783	
Project	: Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		: Refer Topographical survey	
Bore Hole No.	: BH-10	Depth of Ground Water from SGL (in m)	: 1.60		
Location	: Main Plant Area	Date of commencement	: 02.10.2015		
Type of Boring	: Rotary Drilling	Date of Completion	: 16.10.2015		
Dia of Bore/ Sampler	: 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)	Conducted By	: Bhagya Ratna Pattnayak		

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				Remarks
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	ROD Value (%)	
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.50	1.50	Clayey Soil		1.50	SPT	6	6	10	16						Simple Collected
1.50	3.00	1.50	Clay with Sand		3.00	SPT	7	11	19	30						Simple Collected
3.00	4.50	1.50			4.50	SPT	9	12	22	34						Simple Collected
4.50	6.00	1.50	Silty Clay		6.00	SPT	12	19	38	57						Simple Collected
6.00	7.50	1.50			7.50	SPT	9	39	46	85						Simple Collected
7.50	8.00	0.50			8.00	SPT	SPT rebound at 100 blows, 4cm penetration									Sample not Collected
8.00	9.50	1.50	Soft to Chloride		9.50		Double Tube Core Barrel Used									Small pieces Collected
9.50	11.00	1.50			11.00		Double Tube Core Barrel Used									Small pieces Collected
11.00	12.50	1.50			12.50		Double Tube Core Barrel Used									Small pieces Collected
12.50	14.00	1.50			14.00		Double Tube Core Barrel Used									Small pieces Collected
14.00	15.50	1.50			15.50		Double Tube Core Barrel Used									Small pieces Collected
15.50	16.00	0.50			16.00		Double Tube Core Barrel Used									Small pieces Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325361.529 N- 2816027.743

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-10 — Depth of Ground Water from EGL (in m) : 1.60

Location : Main Plant Area — Date of commencement : 02.10.2015

Type of Boring : Rotary Drilling — Date of Completion : 16.10.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted By : Bhagya Rama Pattnayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
							Blows Required for Penetration of depth		N value					
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% ofCore Recovery	RQD Value (%)	
16.00	17.50	1.50	Rock		17.50					Double Tube Core Barrel Used	119	9	29,10,13, 12,14,15	79	62	Sample Collected
17.50	19.00	1.50			19.00					Double Tube Core Barrel Used	118	12	22, 10, 23	79	37	Sample Collected
19.00	20.50	1.50			20.50					Double Tube Core Barrel Used	110	8	16, 31, 15, 20	73	55	Sample Collected
20.50	22.00	1.50			22.00					Double Tube Core Barrel Used	142	8	32,22, 25, 27, 20	95	84	Sample Collected
22.00	23.50	1.50			23.50					Double Tube Core Barrel Used	145	11	10,12, 11, 22, 10, 14, 14	97	62	Sample Collected
23.50	25.00	1.50			25.00					Double Tube Core Barrel Used	113	13	25, 13	75	25	Sample Collected
25.00	26.50	1.50			26.50					Double Tube Core Barrel Used	70	5	17, 19, 20	47	37	Sample Collected
26.50	28.00	1.50	Gravel		28.00					Double Tube Core Barrel Used						Sample Collected
28.00	30.00	2.00			30.00					Double Tube Core Barrel Used						Sample Collected

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BORE LOG DETAILS

Client : NTPC

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.

Bore Hole No. : BH-11

Location : Main Plant

Type of Boring : Rotary Drilling

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)

Coordinates : E- 325493.874 , N 2516758.25

Existing Ground Level (m) : Refer Topographical survey

Depth of Ground Water from EGL (in m) : 2.50

Date of commencement : 27.12.2015

Date of Completion : 02.01.2016

Conducted By : Jitendra Kumar Sahu

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core			
					Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
From	To						0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.60	1.00	1.00	Clay		1.00	SPT	3	5	8	13						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	25	44	65	109						Sample Collected
4.00	5.50	1.50	Silty Sand		5.50	SPT	21	49	73	122						Sample Collected
5.50	7.00	1.50			7.00	SPT	38	79	100	N>100, 4cm Penetration						Sample Collected
7.00	8.50	1.50			8.50	SPT	34	100		N>100, 6cm Penetration						Sample Collected
8.50	10.00	1.50	Soft (or Dh rock		10.00	SPT	100			N>100, 4cm Penetration						Small Pieces Collected
10.00	11.50	1.50	Soft (or Dh rock (Non-coring)		11.50	SPT	100			N>100, 3cm Penetration						Sample not Collected
11.50	13.00	1.50	Pebbles		13.00	SPT	100			N>100, 2cm Penetration						Sample Collected
13.00	14.50	1.50			14.50	SPT	100			N>100, 3cm Penetration						Sample Collected
14.50	16.50	2.00			16.50	SPT	100			N>100, 2cm Penetration						Sample Collected
16.50	18.00	1.50			18.00	SPT	100			N>100, 2cm Penetration						Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325489.674 N- 2615759.25

Project : Geotechnical investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m): Refer Topographical survey

Bore Hole No. : BH-11 — Depth of Ground Water from EGL (in m) : 2.50

Location : Main Plant — Date of commencement : 27.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 02.01.2016

Dia of Bore/ Sampler : 150mm in soil /Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)					Sampling		SPT			Details of Rock Core					
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
18.00	19.50	1.50	Soft to Disrock		19.50	SPT	100	N>100, 3cm Penetration								Sample not Collected
19.50	21.00	1.50	Rock		21.00		Double Tube Core Barrel Used				145	15	28, 21, 12	97	41	Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used				133	10	34, 24, 17, 24, 10	89	72	Sample Collected
22.50	24.00	1.50			24.00		Double Tube Core Barrel Used				149	8	15, 13, 22, 49, 13, 23	99	91	Sample Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used				129	6	23, 19, 66	86	74	Sample Collected
25.50	26.00	0.50			26.00		Double Tube Core Barrel Used				48	2	16, 32	96	96	Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325347.778 N- 2615924.33

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m): Refer Topographical survey

Bore Hole No. : BH-12 — Depth of Ground Water from EGL (in m) : 2.00

Location : Main Plant Area — Date of commencement : 03.11.2015

Type of Boring : Rotary Drilling — Date of Completion : 07.11.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : Binayak Swain

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
From	To	Length of Run (m)			Depth	Type	Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm						
0.00	1.00	1.00	Clay with Sand		1.00	SPT-1	4	6	9	15					Sample Collected
1.00	2.50	1.50	Clayey Sand		2.50	UDS									UDS Failed
2.50	4.00	1.50			4.00	SPT-2	31	47	52	99					Sample Collected
4.00	7.00	3.00	Silty Sand		7.00	SPT-3	35	53	Rebound, N>100. 7cm penetration						Sample Collected
7.00	10.00	3.00			10.00	SPT-4	40	Rebound, N>100. 3cm penetration							Sample not Collected
10.00	13.00	3.00			13.00	SPT-5	100	Rebound, N>100. 4cm penetration							Sample not Collected
13.00	14.50	1.50	Sand with Gravel		14.50	Double Tube Core Barrel Used									Sample Collected
14.50	16.50	2.00	Coarse Sand		16.50	SPT-6	18	24	34	58					Sample Collected
16.50	19.50	3.00			19.50	SPT-7	5	7	17	24					Sample Collected
19.50	22.50	3.00			22.50	SPT-8	9	17	25	42					Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate	E- 325347.776 N- 2615924.33	
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)	Refer Topographical survey	
Bore Hole No.	:	BH-12	Depth of Ground Water from EGL (in m)	2.00	
Location	:	Main Plant Area	Date of commencement	03.11.2015	
Type of Boring	:	Rotary Drilling	Date of Completion	07.11.2015	
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)	Conducted By	Bimayak Swain	

Depth (m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm						
22.50	24.00	1.50	Sand with Gravel		24.00		Double Tube Core Barrel Used								Small pieces Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used								Small pieces Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used								Small pieces Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used								Small pieces Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used								Small pieces Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 3351538.68 N- 2015816.174

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-13 — Depth of Ground Water from EGL (in m) : 3.30

Location : Main Plant — Date of commencement : 27.09.2015

Type of Boring : Rotary Drilling — Date of Completion : 04.10.2015

Dia of Bore/ Samper : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Bhagyak Swain

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core Nb of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.50	1.50	Clay		1.50	SPT	2	3	4	7						Sample Collected
1.50	3.00	1.50			3.00	SPT	2	4	4	8						Sample Collected
3.00	4.50	1.50	Clayey Sand		4.50	UDS										UDS Failed
4.50	6.00	1.50			6.00	SPT	37	N > 100, 5cm penetrated								Sample Collected
6.00	7.50	1.50	Sand		7.50	SPT	50	N > 100, 2cm penetrated								Sample Collected
7.50	9.00	1.50			9.00	SPT	50	N > 100, 2cm penetrated								Sample Collected
9.00	10.00	1.00	Soft (or Dry) rock		10.00		Double Tube Core Barrel Used									Small Pieces Collected
10.00	11.00	1.00			11.00		Double Tube Core Barrel Used									Small Pieces Collected
11.00	12.00	1.00			12.00		Double Tube Core Barrel Used									Small Pieces Collected
12.00	13.00	1.00			13.00		Double Tube Core Barrel Used									Small Pieces Collected
13.00	15.00	2.00			15.00		Double Tube Core Barrel Used				20	5		10		Sample Collected
15.00	16.00	1.00			16.00		Double Tube Core Barrel Used				36	6		36		Sample Collected
16.00	17.00	1.00			17.00		Double Tube Core Barrel Used				33	7		33		Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinates	: E- 225160.635 N- 2615818.174	
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)	:	Refer Topographical survey
Bore Hole No.	:	BH-13	Depth of Ground Water Level Encountered (in m)	:	3.30
Location	:	Main Plant	Date of commencement	:	27.09.2015
Type of Boring	:	Rotary Drilling	Date of Completion	:	04.10.2015
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)	Conducted By	:	BinayakSwain

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
							Blows Required for Penetration of depth							
From	To	Length of Run (m)			Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No.of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
17.00	18.30	1.00	Soft to (I) rock		18.30		Double Tube Core Barrel Used				25	6		25		Sample Collected
18.00	19.30	1.00			19.30		Double Tube Core Barrel Used				34	6		34		Sample Collected
19.00	20.30	1.00			20.30		Double Tube Core Barrel Used				10	2		10		Sample Collected
20.00	21.30	1.00			21.30		Double Tube Core Barrel Used				8	3		8		Sample Collected
21.00	22.30	1.00			22.30	SPT	100	Rebounded at 100 blows, 2cm penetration								Sample not Collected
22.00	23.30	1.00			23.30	SPT	100	Rebounded at 100 blows, 2cm penetration								Sample not Collected
23.00	24.30	1.00			24.30	SPT	100	Rebounded at 100 blows, 3cm penetration								Sample not Collected
24.00	25.30	1.00			25.30		Double Tube Core Barrel Used									Sample Collected
25.00	26.30	1.00			26.30		Double Tube Core Barrel Used									Sample Collected
26.00	27.30	1.00			27.30		Double Tube Core Barrel Used									Sample Collected
27.00	28.30	1.00			28.30	SPT	100	Rebounded at 100 blows, 3cm penetration								Sample not Collected
28.00	29.30	1.00			29.30		Double Tube Core Barrel Used									Small pieces Collected
29.00	30.30	1.00			30.30		Double Tube Core Barrel Used				18	4		15		Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 3253094.582 N- 2618703.259

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-14 — Depth of Ground Water (with EGL (in m) : -

Location : Main Plant — Date of commencement : 23.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 27.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : T. K. Das

Depth (m)				Sampling	SPT					Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Clayey Silt		1.00	SPT	11	12	28	40						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	10	19	31	50						Sample Collected
4.00	5.50	1.50			5.50	SPT	18	26	35	61						Sample Collected
5.50	7.00	1.50	Sand		7.00	SPT	100	N>100, 7cm Penetration								Sample Collected
7.00	8.50	1.50	Pebbles		8.50	SPT	100	N>100, 2cm Penetration								Sample collected from Core barrel
8.50	10.00	1.50			10.00	SPT	100	N>100, 3cm Penetration								Sample Collected from Core barrel
10.00	11.50	1.50	Sand+ silt with Gravels		11.50	SPT	39	100	N>100, 8cm Penetration							Sample Collected
11.50	13.00	1.50			13.00	SPT	52	100	N>100, 6cm Penetration							Sample Collected
13.00	14.50	1.50	Pebbles		14.50	SPT	100	100	N>100, 3cm Penetration							Sample Collected from Core barrel
14.50	16.00	1.50	Sand+ silt with Gravels		16.00	SPT	28	64	N>100, 3cm Penetration							Sample Collected

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BORE LOG DETAILS

Client : **NTPC** Coordinates: E- 326369.582 N- 2615703.259

Project : **Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand** Existing Ground Level (m) : **Refer Topographical survey**

Bore Hole No. : **BH-14** Depth of Ground Water from EGL (in m) : -

Location : **Main Plant** Date of commencement : 23.12.2015

Type of Boring : **Rotary Drilling** Date of Completion : 27.12.2015

Dia of Bore/ Sampler : **150mm in soil (Split Spoon Sampler) ; 75mm in rock (Double Tube Core Barrel)** Conducted By : T. K. Das.

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
							Blows Required for Penetration of depth							
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
16.00	17.50	1.50	Pebbles		17.50	SPT	100	N>100 5cm Penetration								Sample Collected from Core barrel
17.50	19.00	1.50	Rock		19.00		Double Tube Core Barrel Used				147	11	17, 33, 14, 39	98	69	Sample Collected
19.00	21.00	2.00			21.00		Double Tube Core Barrel Used				89	14		45		Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used				70	13		47		Sample Collected
22.50	24.00	1.50			24.00		Double Tube Core Barrel Used				43	7		29		Sample Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used				72	13		48		Sample Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used				65	11	11	43	7	Sample Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used				48	9		32		Sample Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used				103	15	12	69	3	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325379 N- 2615888

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-16 — Depth of Ground Water from EGL (in m) : 2.70

Location : Main Plant — Date of commencement : 28.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 02.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : Mandra Kumar Sahu

Depth (m) From	Depth (m) To	Length of Run (m)	Discription of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Silty Sand		1.00	SPT	9	14	38	52						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	19	34	56	90						Sample Collected
4.00	5.50	1.50			5.50	SPT	26	43	60	103						Sample Collected
5.50	7.00	1.50			7.00	SPT	40	100		N > 100. 11cm Penetration						Sample Collected
7.00	8.50	1.50	Clayey Silt with Gravel		8.50	SPT	72	100		N > 100. 6cm Penetration						Sample Collected
8.50	10.00	1.50	Clayey Silt		10.00	SPT	58	89	100	N>100.4cm Penetration						Sample Collected
10.00	11.50	1.50	Silty Sand		11.50	SPT	44	100		N > 100. 7cm Penetration						Sample Collected
11.50	13.00	1.50	Soft (or Dl) rock		13.00	SPT	100			N > 100. 4cm Penetration			Double Tube Core Barrel Used			Small pieces collected
13.00	14.50	1.50	Soft (or Dl) rock non-coring		14.50	SPT	100			N > 100. 3cm Penetration			Double Tube Core Barrel Used			Sample not Collected
14.50	16.50	2.00	Soft (or Dl) rock		16.50	SPT	100			N > 100. 4cm Penetration			Double Tube Core Barrel Used			Small pieces collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325379 N- 2615868

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-16 — Depth of Ground Water from EGL (in m) : 2.70

Location : Main Plant — Date of commencement : 28.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 02.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)				Log of Bore	Sampling		SPT				Details of Rock Core				
From	To	Length of Run (m)	Description of Strata		Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
18.50	18.00	1.50	Soft (or DI) rock		18.00	SPT	100	N > 100, 2cm Penetration			Double Tube Core Barrel Used					Small pieces collected
18.00	19.50	1.50	Soft (or DI) rock non-coring		19.50	SPT	100	N > 100, 2cm Penetration			Double Tube Core Barrel Used					Sample Collected
19.50	21.00	1.50	Soft (or DI) rock		21.00		Double Tube Core Barrel Used				24	6		16		Sample Collected
21.00	22.50	1.50	Rock		22.50		Double Tube Core Barrel Used				141	16	18, 11, 18, 21	94	45	Sample Collected
22.50	24.00	1.50			24.00		Double Tube Core Barrel Used				113	17	10, 12, 18	75	25	Sample Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used				109	11	10, 21, 27	73	39	Sample Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used				73	9	12, 10	49	15	Sample Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used				45	5	17, 10	30	18	Sample Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used				55	10	12	37	8	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335466. (N- 2915467.

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-17 — Depth of Ground Water from EGL (in m) : 3.10

Location : Main Plant — Date of commencement : 11.01.2013

Type of Boring : Rotary Drilling — Date of Completion : 20.01.2013

Dia of Bore/ Sampler : 150mm in soil /Split Spoon Sampler) : 75mm in rock (Double Tube Core Barrel) — Conducted By : B. R. Pattayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core			
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Silty Clay		1.00	SPT	11	18	28	46						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	10	16	19	35						Sample Collected
4.00	5.50	1.50			5.50	SPT	11	17	20	37						Sample Collected
5.50	7.00	1.50			7.00	SPT	13	16	21	37						Sample Collected
7.00	8.50	1.50			8.50	SPT	18	21	27	48						Sample Collected
8.50	10.00	1.50			10.00	SPT	20	25	33	58						Sample Collected
10.00	11.50	1.50			11.50	SPT	18	22	31	53						Sample Collected
11.50	13.00	1.50			13.00	SPT	20	24	35	59						Sample Collected
13.00	14.50	1.50			14.50	SPT	25	29	36	65						Sample Collected
14.50	16.00	1.50			16.00	SPT	27	32	40	72						Sample Collected

Sand

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BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand
Bore Hole No. : BH-17
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil /Split Spoon Sampler 76mm in rock /Double Tube Core Barrel

Coordinate E- 325485 N- 2815887
Existing Ground Leve (m) Refer Topographical survey
Depth of Ground Water from EGL (in m) : 3.10
Date of commencement : 11.01.2016
Date of Completion : 20.01.2016
Conducted By : B. R. Pattnayek

Depth (m)				Sampling		SPT				Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.00	17.50	1.50	Sand		17.50	SPT	31	36	43	79						Sample Collected
17.50	19.00	1.50			19.00	SPT	29	35	44	79						Sample Collected
19.00	20.50	1.50			20.50	SPT	33	36	47	83						Sample Collected
20.50	22.00	1.50			22.00	SPT	28	45	57	102						Sample Collected
22.00	23.50	1.50			23.50	SPT	37	47	55	102						Sample Collected
23.50	25.00	1.50	Rock		25.00		Double Tube Core Barrel Used				66	8	10, 10, 12, 13	44	30	Sample Collected
25.00	26.50	1.50			26.50		Double Tube Core Barrel Used				77	9	14, 18, 19	51	28	Sample Collected
26.50	28.00	1.50			28.00		Double Tube Core Barrel Used				81	12	11, 10, 10, 18, 12	54	39	Sample Collected
28.00	30.00	2.00			30.00		Double Tube Core Barrel Used				142	11	16, 18, 11, 15, 12	71	35	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325567 N- 2616239

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No. : BH-18 — Depth of Ground Water from EGL (in m) : -4.00

Location : Main Plant — Date of commencement : 23.11.2015

Type of Boring : Rotary Drilling — Date of Completion : 01.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : B. R. Pattnayak

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core					Remarks
From	To	Length of Run (m)			Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
0.00	1.00	1.00	Moorum		1.00	SPT	10	14	16	30						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	100	SPT Rebounded, N>100, 5cm Penetration								Sample not Collected
4.00	5.50	1.50			5.50	SPT	100	SPT Rebounded, N>100, 2cm Penetration								Sample not Collected
5.50	7.00	1.50	Soft (or Ely) Wet		7.00		Double Tube Core Barrel Used				55	11		37		Sample Collected
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used				60	15		40		Sample Collected
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used				82	13		55		Sample Collected
10.00	11.50	1.50			11.50		Double Tube Core Barrel Used				52	7		35		Sample Collected
11.50	13.00	1.50	Carbonise Clay		13.00		Double Tube Core Barrel Used									Small Pieces Collected
13.00	14.50	1.50	Coal		14.50		Double Tube Core Barrel Used									Small Pieces Collected
14.50	16.00	1.50			16.00		Double Tube Core Barrel Used				30	15		20		Sample Collected
16.00	17.50	1.50			17.50		Double Tube Core Barrel Used				45	12		30		Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used				65	8	10, 13, 17	43	27	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325597 N- 2616239

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at FTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-18 — Depth of Ground Water from EGL (in m) : -.00

Location : Main Plant — Date of commencement : 23.11.2015

Type of Boring : Rotary Drilling — Date of Completion : 01.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : B. R. Pattnayak

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT		Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm / 15 - 30 cm / 30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
19.00	20.50	1.50	Coal		20.50		Double Tube Core Barrel Used		67	15	12	45	8	Sample Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used		60	6	11, 15, 12	40	25	Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used		62	10		41		Sample Collected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used		70	12		47		Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinates : E- 325271 N- 2616057

Project : Geotechnical Investigation Work (for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-19 — Depth of Ground Water from EGL (in m) : -

Location : Main Plant — Date of commencement : 21.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 25.12.2015

Dia of Bore/ Sampler : 150mm n sol (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth								
From	To	Length of Run (m)			Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Clay Soil		1.00	SPT	2	4	7	11						Sample Collected
1.00	2.50	1.50			2.50	UDS										Sample Collected
2.50	4.00	1.50	Silty Sand		4.00	SPT	49	57	100	N > 100						Sample Collected
4.00	5.50	1.50			5.50	SPT	59	100		N > 100						Sample Collected
5.50	7.00	1.50			7.00	SPT	90	100		N > 100						Sample Collected
7.00	8.50	1.50			8.50	SPT	100			N > 100						Sample not Collected
8.50	10.00	1.50			10.00	SPT	100			N > 100						Sample Collected
10.00	11.50	1.50	Soft to Dhoras		11.50	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces Collected
11.50	13.00	1.50	Sand Stone		13.00	Double Tube Core Barrel Used					56	7	26	37	17	Sample Collected
13.00	14.50	1.50			14.50	SPT	100			N > 100	Double Tube Core Barrel Used					Sample not Collected
14.50	16.50	2.00			16.50	Double Tube Core Barrel Used					72	13	20	35	10	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinates: E- 325271 N-2616957

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No : BH-19 — Depth of Ground Water from EGL (in m) : -

Location : Main Plant — Date of commencement : 21.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 25.12.2015

Dia of Bore/ Sampler : 150mm ie soil (Split Soon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)				Sampling		SFT				Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm / 15 - 30 cm / 30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.50	18.00	1.50	Sand,Stone		18.00		Double Tube Core Barrel Used		76	6	20, 24	51	29	Sample Collected
18.00	19.50	1.50			19.50		Double Tube Core Barrel Used		22	8	13	15	9	Sample Collected
19.50	21.00	1.50			21.00		Double Tube Core Barrel Used		52	10		35		Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used		15	7		10		Sample Collected
22.50	24.00	1.50			24.00	SPT	100	N = 100	Double Tube Core Barrel Used					Small pieces Collected
24.00	25.00	1.00			25.00		Double Tube Core Barrel Used		48	7		18		Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335485 N- 2615988

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-21 — Depth of Ground Water from EGL (in m) : 6.70

Location : Main Plant — Date of commencement : 18.12.2015

Type of Boring : Rotary Drilling — Date of Completion : 21.12.2015

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : P. K. Das

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				Remarks
							Blows Required for Penetration of depth			N value					
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm		Total Length (cm)	No.of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
0.00	1.00	1.00	Silty Clay		1.00	SPT	4	6	8	14						Sample Collected
1.00	2.50	1.50	Silty Sand		2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	49	100		N>100. 0cm Penetration						Sample Collected
4.00	5.50	1.50			5.50	SPT	100			N>100. 4cm Penetration						Sample Collected
5.50	7.00	1.50			7.00	SPT	100			N>100 5cm Penetration						Sample Collected
7.00	8.50	1.50			8.50	SPT	100			N>100. 6cm Penetration						Sample not Collected
8.50	10.00	1.50			10.00	SPT	100			N>100 3cm Penetration						Sample Collected
10.00	12.00	2.00	Soft (or DI) rock		12.00		Double Tube Core Barrel Used				14	9	7	7		Sample Collected
12.00	13.50	1.50	Soft (or DI) rock (more Coring)		13.50	SPT	100			N>100. 2cm Penetration						Sample not Collected
13.50	15.00	1.50			15.00		Double Tube Core Barrel Used				32	8	21	21		Sample Collected
15.00	16.50	1.50	Soft (or DI) rock		16.50		Double Tube Core Barrel Used				12	3	9	9		Sample Collected
16.50	18.00	1.50			18.00	SPT	100			N>100. 2cm Penetration	Double Tube Core Barrel Used					Small Pieces Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client	:	NTPC	Coordinate	E- 325093	N- 2616309	
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical survey	
Bore Hole No	:	BH-48	Depth of Ground Water from EGL (in m)	:	1.70	
Location	:	Main Plant	Date of commencement	:	04.01.2016	
Type of Boring	:	Rotary Drilling	Date of Completion	:	09.01.2016	
Dia of Bore/ Sampler	:	150mm in soil /Split Spoon Sampler - 75mm in rock (Double Tube Core Barrel)	Conducted By	:	Jitendra Kumar Sahu	

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
16.00	17.50	1.50	Soft (or Dil) rock		17.50		Double Tube Core Barrel Used				20	5		13		Sample Collected
17.50	19.00	1.50	Rock		19.00		Double Tube Core Barrel Used				35	5	11	23	7	Sample Collected
19.00	20.00	1.00			20.00		Double Tube Core Barrel Used				35	3	24	35	24	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinates : E- 235059 N- 2615478

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-49 — Depth of Ground Water from EGL (in m) : -2.30

Location : Main Plant — Date of commencement : 07.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 08.01.2016

Dia of Boar/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel) — Conducted by : Jitendra Kumar

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Clayey Silt		1.00	SPT	3	7	10	17						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Silty Sand		4.00	SPT	43	58	68	126						Sample Collected
4.00	5.50	1.50			5.50	SPT	53	67	100	167						Sample Collected
5.50	7.00	1.50			7.00	SPT	100	N > 100, 6cm Penetration								Sample not Collected
7.00	8.50	1.50	Rock		8.50	SPT	100	N > 100, 3cm Penetration								Small pieces of core collected
8.50	10.00	1.50	Soft /or Dis rock		10.00	Double Tube Core Barrel Used				40	6	15	27	10		Sample Collected
10.00	11.50	1.50			11.50	SPT	100	N > 100, 2cm Penetration								Sample not Collected
11.50	13.00	1.50			13.00	SPT	100	N > 100, 3cm Penetration								Small pieces of core collected
13.00	15.00	2.00	Rock		15.00	Double Tube Core Barrel Used				78	7	15.11.27	38	27		Sample Collected
15.00	16.50	1.50			16.50	Double Tube Core Barrel Used				40	4	22	27	15		Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 325059	N- 2615478	
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical survey	
Bore Hole No.	:	BH-49	Depth of Ground Water from EGL (in m)	:	2.30	
Location	:	Main Plant	Date of commencement	:	07.01.2016	
Type of Boring	:	Rotary Drilling	Date of Completion	:	09.01.2016	
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	:	Jitendra Kumar	

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
							Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
From	To				Depth	Type	0 - 15 cm	15 - 30 cm / 30 - 45 cm							
16.50	18.00	1.50	Rock		18.00		Double Tube Core Barrel Used			58	5	15, 23, 14	39	36	Sample Collected
18.00	20.00	2.00			20.00		Double Tube Core Barrel Used			41	4	11,16	21	14	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E 325208 N 2615486

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-50 — Depth of Ground Water from EGL (in m) : 3.50

Location : Main Plant — Date of commencement : 11.01.2016

Type of Boring : Rotary Drilling — Date of completion : 13.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (mm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Mocrum		1.00	SPT	11	23	39	62						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Silty Sand		4.00	SPT	18	32	66	98						Sample Collected
4.00	5.50	1.50	Sand		5.50	SPT	23	49	71	120						Sample Collected
5.50	7.00	1.50			7.00	SPT	57	69	100	169						Sample Collected
7.00	8.50	1.50	Coarse Sand		8.50	SPT	73	100	N > 100, 3cm Penetration							Sample Collected
8.50	10.00	1.50	Coarse Sand with Small Gravel		10.00	SPT	83	100	N > 100, 6cm Penetration							Sample Collected
10.00	11.50	1.50	Soft (wr DI) rock		11.50	SPT	100	N > 100, 3cm Penetration								Sample not Collected
11.50	13.00	1.50			13.00	SPT	100	N > 100, 4cm Penetration								Small Pieces Collected
13.00	14.50	1.50			14.50	SPT	100	N > 100, 5cm Penetration								Sample Collected
14.50	16.00	1.50	Fractured Rock		16.00	SPT	100	N > 100, 3cm Penetration								Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 325208	N- 2915486
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)	Refer Topographical survey	
Bore Hole No.	:	BH-50	Depth of Ground Water from EGL (in m	: 3.50	
Location	:	Main Plant	Date of commencement	: 11.01.2016	
Type of Boring	:	Rotary Drilling	Date of Completion	: 13.01.2016	
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) ;76mm in rock(Double Tube Core Barrel)	Conducted By	: Jitendra Kumar Sahu	

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				Remarks
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
							0- 15 cm	15 - 30 cm	30 - 45 cm							
16.00	17.50	150	Fractured Rock		17.50	SPT	100	N >100, 1cm Penetration			18	4		12		Sample Collected
17.50	19.00	150			19.00	SPT	100	N >100, 0cm Penetration			25	5		17		Sample Collected
19.00	20.00	100			20.00	SPT	100	N >100, 1cm Penetration								Sample not Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 324914 N- 2654361

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Rater Topographical survey

Bore HoleNo : BH-51 — Depth of Ground Water from EGL (in m) : 1.20

Location : Main Plant — Date of commencement : 15.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 17.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Rajran Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth			N value	Total Length (cm)	No of Races	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Clay		1.00	SPT	4	7	9	16						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Collected
2.50	4.00	1.50	Soft (or Dil) rock		4.00	SPT	64	100		N > 100, 6cm Penetration						Sample Collected
4.00	5.50	1.50			5.50	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
5.50	7.00	1.50			7.00	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
7.00	8.50	1.50			8.50	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
8.50	10.00	1.50	Fractured rock		10.00	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
10.00	11.50	1.50	Rock		11.50	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
11.50	13.00	1.50			13.00	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
13.00	14.50	1.50			14.50	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected
14.50	16.00	1.50			16.00	SPT	100			N > 100	Double Tube Core Barrel Used					Small pieces collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 324912	N- 2615436
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Toooatsphical survey
Bore Hole No.	:	BH-51	Depth of Ground Water from EGL (in m)	:	1.20
Location	:	Main Plant	Date of commencement	:	15.01.2016
Type of Boring	:	Rotary Drilling	Date of Completion	:	17.01.2016
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	:	Rajam Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT		Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm / 15 - 30 cm / 30 - 45 cm							
16.00	17.50	1.50	Rock		17.50		Double Tube Core Barrel Used		33	5		22		Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used		31	5		21		Sample Collected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used		37	6	12	25	8	Sample Collected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used		40	4		27		Sample Collected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used		51	7		34		Sample Collected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used		39	8		28		Sample Collected

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BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.
Bore Hole No. : BH-52
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)

Coordinate : E- 325038 N- 2615326
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water from EGL (in m) : 3.20
Date of commencement : 10.01.2016
Date of Completion : 13.01.2016
Conducted By : Rajaram Sahoo

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of pcre greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Clay soil with Moorum		1.00	SPT	9	12	19	31						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Collected
2.50	4.00	1.50	Silty Sand		4.00	SPT	20	52	68	120						Sample Collected
4.00	5.50	1.50			5.50	SPT	32	49	73	122						Sample Collected
5.50	7.00	1.50			7.00	SPT	54	69	100	169						Sample Collected
7.00	8.50	1.50			8.50	SPT	72	100	N > 100, 12cm Penetration							Sample Collected
8.50	10.00	1.50			10.00	SPT	82	100	N > 100, 5cm Penetration							Sample Collected
10.00	11.50	1.50	Soft (or DI) rock		11.50	SPT	100	N > 100								Sample not Collected
11.50	13.00	1.50	Fractured rock		13.00	SPT	100	N > 100			30	17		20		Sample Collected
13.00	14.50	1.50			14.50	SPT	100	N > 100, 1cm Penetration			36	12		24		Sample Collected
14.50	16.00	1.50			16.00	SPT	100	N > 100, 2cm Penetration								Small pieces collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E 325038	N- 2615329
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical survey
Bore Hole No.	:	BH-52	Depth of Ground Water from EGL (in m)	:	3.20
Location	:	Main Plant	Date of commencement	:	10.01.2016
Type of Boring	:	Rotary Drilling	Date of Completion	:	13.01.2016
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mmin rock (Double Tube Core Barrel)	Conducted By	:	Rajaram Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
16.00	17.50	1.50	Fractured rock		17.50	SPT	100		N > 100							Small pieces collected
17.50	19.00	1.50			19.00	SPT	100		N > 100							Small pieces collected
19.00	20.00	1.00			20.00	SPT	100		N > 100, 1cm Penetration							Small pieces collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 225196.04 N- 2615003.671

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topo/Technical survey/

Bore Hole No : BH-15 — Depth of Ground Water from EGL (in m) : Could t measure due to water loss

Location : Main Plant — Date of commencemen : 19.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 24.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Partha Pritam Rout

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
From	To	Length of Run (m)			Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Moorum		1.00	SPT	8	31	38	69						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Sand		4.00	SPT	13	28	34	62						Sample Collected
4.00	5.50	1.50	Soft to DI rock		5.50		Double Tube Core Barrel Used				21	4		14		Sample Collected
5.50	7.00	1.50	Rock		7.00		Double Tube Core Barrel Used				42	6	23	28	15	Sample Collected
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used				34	5	4	23	8	Sample Collected
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used				36	6		24		Sample Collected
10.00	11.50	1.50			11.50		Double Tube Core Barrel Used				76	9	15 - 6, 21	51	35	Sample Collected
11.50	13.00	1.50			13.00		Double Tube Core Barrel Used				71	8	25, 26, 10	47	41	Sample Collected
13.00	15.00	2.00			15.00		Double Tube Core Barrel Used				74	14	10, 11	37	11	Sample Collected
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used				66	12	12 - 3, 14	44	26	Sample Collected
16.50	18.00	1.50			18.00		Double Tube Core Barrel Used				106	14	12 - 7, 14	71	29	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinates : E- 325196.04 N- 2615003.671

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-15 — Depth of Ground Water from EGL (in m) : Couldn't measure due to water loss

Location : Main Plant — Date of commencement : 19.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 24.01.2016

Dia of Bore/ Sampler : 150mm mesoil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Partha Pritam Rout

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth		N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm / 30 - 45 cm							
18.00	19.50	1.50	Rock		19.50		Double Tube Core Barrel Used			70	11	16, 13	47	19	Sample Collected
19.50	21.00	1.50			21.00		Double Tube Core Barrel Used			82	8	37, 11	55	32	Sample Collected
21.00	22.50	1.50			22.50		Double Tube Core Barrel Used			61	6	32	41	21	Sample Collected
22.50	24.00	1.50			24.00		Double Tube Core Barrel Used			68	15		45		Sample Collected
24.00	25.50	1.50			25.50		Double Tube Core Barrel Used			80	8	15, 21, 32	53	45	Sample Collected
25.50	27.00	1.50			27.00		Double Tube Core Barrel Used			55	3	44	37	29	Sample Collected
27.00	28.50	1.50			28.50		Double Tube Core Barrel Used			72	2	58, 13	48	47	Sample Collected
28.50	30.00	1.50			30.00		Double Tube Core Barrel Used			62	1	62	41	41	Sample Collected

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BORE LOG DETAILS

Client	: NTPC	Coordinate:	E- 325183	N- 2619350	
Project	: Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)	: Refer Topographical survey.		
Bore Hole No.	: BH-23	Depth of Ground Water from (GL) (in m)	: 2.40		
Location	: Main Plant	Date of commencement	: 11.01.2016		
Type of Boring	: Rotary Drilling	Date of Completion	: 14.01.2016		
Dia of Bore/ Sampler	: 150mm in soil /Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	: Jitendra Kumar Sahu		

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		Details of Rock Core						
							SPT						
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
0.00	1.00	1.00	Moorum		1.00	SPT	15	22	23	45						Sample Coleted
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Moorum with Clay		4.00	SPT	17	19	21	40						Sample Coleted
4.00	5.50	1.50			5.50	SPT	17	20	27	47						Sample Coleted
5.50	7.00	1.50	Sandy Clay		7.00	SPT	30	43	100	143						Sample Coleted
7.00	8.50	1.50	Rock		8.50	Double Tube Core Barrel Used					38	6		25		Sample Coleted
8.50	10.00	1.50	Soft (or Dry) rock		10.00	SPT	100	N > 100, 0cm Penetration								Small pieces collected
10.00	11.50	1.50			11.50	SPT	100	N > 100, 0cm Penetration								Small pieces collected
11.50	13.00	1.50			13.00	SPT	100	N > 100, 0cm Penetration								Small pieces collected
13.00	15.00	2.00	Fractured Rock		15.00	SPT	100	N > 100, 0cm Penetration								Small pieces collected
15.00	16.50	1.50			16.50	SPT	100	N > 100, 0cm Penetration								Small pieces collected

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BORE LOG DETAILS

Client : **NTPC** — Coordinate : E- 326133 N- 2615350

Project : **Geotechnical investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.** — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-53 — Depth of Giound Water from EGL (in m) : 2.40

Location : Main Plant — Date of commencement : 11.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 14.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) ; 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth			N value					
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm		Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.50	18.00	1.50	Fractured Rock		18.00	SPT	100	N > 100, 3cm Penetration								Small pieces collected
18.00	20.00	2.00			20.00	SPT	100	N > 100, 1cm Penetration			24	7		12		Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335281 N- 2915283

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-54 — Depth of Ground Water from EGL (in m) : 3.20

Location : Main Plant — Date of commencement : 23.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 25.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Partha Pritam Raut

Depth(m)			Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth								
From	To	Length of Run (m)			Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Moorum with Clay		1.00	SPT	12	18	24	42						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50			4.00	SPT	8	22	31	53						Sample Collected
4.00	5.50	1.50			5.50	SPT	11	19	36	55						Sample Collected
5.50	7.00	1.50	Soft (of D)rock		7.00		Double Tube Core Barrel Used									Small pieces collected
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used									Small pieces collected
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used									Small pieces collected
10.00	11.50	1.50			11.50		Double Tube Core Barrel Used									Small pieces collected
11.50	13.00	1.50			13.00		Double Tube Core Barrel Used									Small pieces collected
13.00	14.50	1.50			14.50		Double Tube Core Barrel Used									Small pieces collected
14.50	16.00	1.50			16.00		Double Tube Core Barrel Used									Small pieces collected

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BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.
Bore HoleNo. : BH-S4
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler), 75mm in rock (Double Tube Core Barrel)

Coordinate E- 325287 N- 2615283
Existing Ground Level (m) : Refer Topographical survey
Depth of Ground Water from EGL (in m) : 3.20
Date of commencement : 23.01.2016
Date of Completion : 25.01.2016
Conducted By : Partha Pritam Rout

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
16.00	17.50	1.50	Soft (or DI) rock		17.50		Double Tube Core Barrel Used									Small pieces collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used									Small pieces collected
19.00	20.00	1.00			20.00		Double Tube Core Barrel Used									Small pieces collected

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BORE LOG DETAILS

Client : NTPC
Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.
Bore Hole No : BH-59
Location : Main Plant
Type of Boring : Rotary Drilling
Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel)

Coordinates : E- 335043 N- 2314909
Existing Ground Leve (m) : Refer Topographical Survey
Depth of Ground Water from EGL (in m) : 3.20
Date of commencement : 25.01.2016
Date of Completion : 28.01.2016
Conducted By : Partha Pritam Rout

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Moorum		1.00	SPT	13	16	26	42						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Gravel		4.00		Double Tube Core Barrel Used									Small peces stones collected
4.00	5.50	1.50			5.50		Double Tube Core Barrel Used									Small peces stones collected
5.50	7.00	1.50	Soft (or Ell) rock		7.00		Double Tube Core Barrel Used									Small peces collected
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used									Small peces collected
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used									Small peces collected
10.00	11.50	1.50			11.50		Double Tube Core Barrel Used									Small peces collected
11.50	13.00	1.50			13.00		Double Tube Core Barrel Used				38	3		25		Sample Collected

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BORE LOG DETAILS

Client	:	NTPC	Coordinate:	E- 325343	N 2614929
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground Level (m)		Refer Topographical survey
Bore Hole No.	:	BH-59	Depth of Ground Water from EGL (in m)	:	3.20
Location	:	Main Plant	Date of commencement	:	25.01.2016
Type of Boring	:	Rotary Drilling	Date of Completion	:	28.01.2016
Dia of Bore/ Sampler	:	165mm in soil (Split Spoon Sampler) 75mm in rock (Double Tube Core Barrel)	Conducted By	:	Partha Pritam Rout

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
13.00	14.50	1.50	Rock		14.50		Double Tube Core Barrel Used				41	6	10, 11	27	14	Sample Collected
14.50	16.00	1.50			16.00		Double Tube Core Barrel Used				48	8	12,13	31	17	Sample Collected
16.00	17.50	1.50	Rock		17.50		Double Tube Core Barrel Used				78	9	11,14, 10	51	23	Sample Collected
17.50	19.00	1.50			19.00		Double Tube Core Barrel Used				67	12	10, 18, 20	45	32	Sample Collected
19.00	20.00	1.00			20.00		Double Tube Core Barrel Used				43	10	11, 10, 14, 10	42	45	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325173 N-2515116

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS, Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-60 — Depth of Ground Water from EGL (in m) : 6.50

Location : Main Plant — Date of commencement : 18.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 18.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) / 75mm in rock (Double Tube Core Barrel) — Conducted By : Partha Pritam Rout.

Depth (m) From	Depth (m) To	Length of Rvn (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.00	1.00	Moorum		1.00	SPT	10	18	22	40						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Soft (or DI rock		4.00		Double Tube Core Barrel Used				31	5		21		Sample Collected
4.00	5.50	1.50			5.50		Double Tube Core Barrel Used				28	9		19		Sample Collected
5.50	7.00	1.50	Rock		7.00		Double Tube Core Barrel Used				111	8	43, 42	74	57	Sample Collected
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used				118	16	12, 14, 13, 41	79	53	Sample Collected
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used				135	5	38, 27, 17, 34	90	75	Sample Collected
10.00	11.00	1.00			11.00		Double Tube Core Barrel Used				60	1	60	60	60	Sample Collected
11.00	12.50	1.50			12.50		Double Tube Core Barrel Used				140	3	34, 37, 12	93	89	Sample Collected
12.50	14.00	1.50			14.00		Double Tube Core Barrel Used				149	5	71, 32, 44	98	97	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 335343 — N- 2615073

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical Survey

Bore Hole No. : BH-#1 — Depth of Ground Water from EGL (in m) : 2.30

Location : Main Plant — Date of commencement : 23.01.2016

Type of Borng : Rotary Drilling — Date of Completion : 26.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQC Value (%)	Remarks
0.00	1.00	1.00	Silty Soil		1.00	SPT	5	9	12	21						Sample Coleted
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Rock		4.00		Double Tube Core Barrel Used				40	5		27		Sample Coleted
4.00	5.50	1.50			5.50		Double Tube Core Barrel Used				36	6		24		Sample Coleted
5.50	7.00	1.50			7.00		Double Tube Core Barrel Used				47	5	11, 10	31	14	Sample Coleted
7.00	8.50	1.50			8.50		Double Tube Core Barrel Used				38	7	14	25	9	Sample Coleted
8.50	10.00	1.50			10.00		Double Tube Core Barrel Used				41	8		27		Sample Coleted
10.00	11.50	1.50			11.50		Double Tube Core Barrel Used				52	7		35		Sample Coleted
11.50	13.50	2.00			13.50		Double Tube Core Barrel Used				55	5		28		Sample Coleted
13.50	15.00	1.50			15.00		Double Tube Core Barrel Used				74	8	18	49	12	Sample Coleted
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used				45	6	11	30	7	Sample Coleted

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BORE LOG DETAILS

Client	:	NTPC	Coordinate: E- 335343	N- 2615073	
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand	Existing Ground Level (m)	Refer Topographical survey	
Bore Hole No.	:	BH-61	Depth of Ground Water from EGL (mm)	: 2.30	
Location	:	Main Plant	Date of commencement	: 23.01.2016	
Type of Boring	:	Rotary Drilling	Date of Completion	: 26.01.2016	
Dia of Bore/ Sampler	:	150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	: Jitendra Kumar Sahu	

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
From	To				Depth	Type	Blows Required for Penetration of depth			N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm							
16.50	18.00	1.50	Rock		18.00		Double Tube Core Barrel Used				43	5	15	29	10	Sample Collected
18.00	20.00	2.00			20.00		Double Tube Core Barrel Used				65	6	33	33	17	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate : E- 325434 N- 2815192

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-62 — Depth of Ground Water from EGL (in m) : 170

Location : Main Plant — Date of commencement : 15.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 18.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT			Details of Rock Core				
							Blows Required for Penetration of depth		N value					
From	To				Depth	Type	0 - 15 cm	15 - 30 cm / 30 - 45 cm		Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
0.00	1.50	1.50	Rock		1.50		Double Tube Core Barrel Used			67	8	20, 12	45	21	Sample Collected
1.50	3.00	1.50			3.00		Double Tube Core Barrel Used			36	8		24		Sample Collected
3.00	4.50	1.50	Fractured Rock		4.50		Double Tube Core Barrel Used			81	13	42	54	28	Sample Collected
4.50	6.00	1.50			6.00		Double Tube Core Barrel Used			45	10	0	30	7	Sample Collected
6.00	7.50	1.50	Rock		7.50		Double Tube Core Barrel Used			53	4	16, 24	35	27	Sample Collected
7.50	9.00	1.50			9.00		Double Tube Core Barrel Used			47	6	18, 13	31	21	Sample Collected
9.00	10.50	1.50			10.50		Double Tube Core Barrel Used			34	7		23		Sample Collected
10.50	12.00	1.50			12.00		Double Tube Core Barrel Used			44	6	5	29	10	Sample Collected
12.00	13.50	1.50			13.50		Double Tube Core Barrel Used			50	10		33		Sample Collected
13.50	15.00	1.50			15.00		Double Tube Core Barrel Used			42	5	5	28	10	Sample Collected
15.00	16.50	1.50			16.50		Double Tube Core Barrel Used			38	4	1	25	7	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325434 N- 2615192

Project : Geotechnical Investigation Work for proposedmain Plant andAsh Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-02 — Depth of Ground Water from EGL (in m) : 1.70

Location : Main Plant — Date of commencement : 15.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 18.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kuma Sahu

Depth(m)				Log of Bore	Sampling		SPT			Details of Rock Core					
From	To	Length of Run (m)	Description of Strata		Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
16.50	18.00	1.50	Rock		18.00		Double Tube Core Barrel Used				43	6		29		Sample Collected
18.00	20.00	2.00			20.00		Double Tube Core Barrel Used				51	7	13, 14	26	14	Sample Collected

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BORE LOG DETAILS

Client : NTPC — Coordinate: E- 325863 N- 2614877

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No. : BH-57 — Depth of Ground Water from EGL (in m) : 1.20

Location : Main Plant — Date of commencement : 27.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 29.01.2016

Dia of Bore/ Sampler : 150mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahoo

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT Blows Required for Penetration of depth 15 - 30 cm	SPT Blows Required for Penetration of depth 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Sand		1.00	SPT	2	3	5	8						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Failed
2.50	4.00	1.50	Moorum with Clay		4.00	SPT	9	14	19	33						Sample Collected
4.00	5.50	1.50	Clay		5.50	SPT	11	18	21	39						Sample Collected
5.50	7.00	1.50			7.00	SPT	22	25	38	63						Sample Collected
7.00	8.50	1.50	soft (or DI) rock		8.50	SPT	10C	N > 100			Double Tube Core Barrel Used					Small pieces collected
8.50	10.00	1.50			10.00	SPT	10C	N > 100			Double Tube Core Barrel Used					Small pieces collected
10.00	11.50	1.50			11.50	SPT	10C	N > 100			Double Tube Core Barrel Used					Small pieces collected
11.50	13.00	1.50	Rock		13.00		Double Tube Core Barrel Used				30	7		20		Sample Collected
13.00	14.50	1.50			14.50		Double Tube Core Barrel Used				36	9		24		Sample Collected

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BORE LOG DETAILS

Client : NTPC

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.

Bore Hole No. : BH-07

Location : Main Plant

Type of Boring : Rotary Drilling

Dia of Bore/ Samper : 150mm in soil/Split Spoon Sampler, 75mm in rock (Double Tube Core Barrel)

Coordinate : E- 325683 N- 264877

Existing Ground Level (m) : Refer Topographical survey

Depth of Ground Water from EGL (in m) : 1.20

Date of commencement : 27.01.2016

Date of Completion : 29.01.2016

Conducted By : Jitendra Kumar Sahoo

Depth(m)				Sampling		SPT			Details of Rock Core				
From	To	Length of Run (m)	Description of Strata	Log of Bore	Depth	Type	Blows Required for Penetration of depth 0 - 15 cm / 15 - 30 cm / 30 - 45 cm	N Value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
14.50	16.00	1.50	Rock		16.00		Double Tube Core Barrel Used		42	6		28		Sample Colected
16.00	17.50	1.50			17.50		Double Tube Core Barrel Used		38	8	10, 11	25	14	Sample Colected
17.50	19.50	2.00			19.50		Double Tube Core Barrel Used		93	9	12, 10 11 14	47	24	Sample Colected
19.50	20.00	0.50			20.00		Double Tube Core Barrel Used		48	4	10,10,12	96	64	Sample Colected

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BORE LOG DETAILS

Client : NTPC — Coordinates : E- 326528 N- 2614956

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Level (m) : Refer Topographical survey

Bore Hole No : BH-03 — Depth of Ground Water from EGL (in m) : 0.50

Location : Main Plant — Date of commencement : 20.01.2018

Type of Boring : Rotary Drilling — Date of Completion : 22.01.2018

Dia of Bore/ Sampler : 150mm in soil/Split Spoon Sampler/ 75mm in rock (Double Tube Core Barrel) — Conducted By : Jitendra Kumar Sahu

Depth(m) From	Depth(m) To	Length of Run (m)	Description of Strata	Log of Bore	Sampling Depth	Sampling Type	SPT Blows Required for Penetration of depth 0 - 15 cm	SPT 15 - 30 cm	SPT 30 - 45 cm	SPT N value	Details of Rock Core Total Length (cm)	Details of Rock Core No of Pieces	Details of Rock Core Length of core greater than 10cm	Details of Rock Core % of Core Recovery	Details of Rock Core RQD Value (%)	Remarks
0.00	1.00	1.00	Ash		1.00	SPT	2	4	5	9						Sample Collected
1.00	2.50	1.50	Ash		2.50	UDS										UDS Failed
2.50	4.00	1.50	Sand		4.00	SPT	5	6	27	33						Sample Collected
4.00	5.50	1.50	Sand		5.50	SPT	9	11	31	42						Sample Collected
5.50	7.00	1.50	Soft (dri bil) rock		7.00	SPT	91	100	N > 100. 0cm Penetration		Double Tube Core Barrel Used					Small Pieces Collected
7.00	8.50	1.50	Soft (dri bil) rock		8.50	SPT	100	N > 100. 0cm Penetration			Double Tube Core Barrel Used					Small Pieces Collected
8.50	10.00	1.50	Rock		10.00		Double Tube Core Barrel Used			42	8		28			Sample Collected
10.00	11.50	1.50	Rock		11.50		Double Tube Core Barrel Used			97	5	33, 33, 28	65	65		Sample Collected
11.50	13.00	1.50	Rock		13.00		Double Tube Core Barrel Used			120	10	63, 13	80	51		Sample Collected
13.00	14.50	1.50	Rock		14.50		Double Tube Core Barrel Used			121	11	13, 12, 13, 12, 13 + 1, 13	81	58		Sample Collected
14.50	16.00	1.50	Rock		16.00		Double Tube Core Barrel Used			118	12	10, 14, 17, 14, 12, 16	79	55		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client	:	NTPC	Coordinate	E- 326175	N- 2815409
Project	:	Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand.	Existing Ground level(m)	Prefer Topographical survey	
Bore Hole No	:	BH-66	Depth of Ground Water from EGL (in m)	5.00	
Location	:	Main Plant	Date of commencement	22.01.2016	
Type of Boring	:	Rotary Drilling	Date of Completion	24.01.2016	
Dia of Bore/ Sampler	:	~50mm in soil (Split Spoon Sampler) , 75mm in rock (Double Tube Core Barrel)	Conducted By	Rajaram Sahoo	

Depth(m)		Length of Rm (m	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				Remarks
							Blows Required for Penetration of depth								
From	To				Depth	Type	0 - 15 cm	15 - 30 cm	30 - 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
0.00	1.00	1.00	Ash		1.00	SPT	7	6	4	10						Sample Collected
1.00	2.50	1.50			2.50	UDS										UDS Collected
2.50	4.00	1.50	Clay Semi		4.00	SPT	9	11	10	21						Sample Collected
4.00	5.50	1.50			5.50	SPT	13	14	15	29						Sample Collected
5.50	7.00	1.50			7.00	SPT	12	11	12	23						Sample Collected
7.00	8.50	1.50			8.50	SPT	11	9	14	23						Sample Collected
8.50	10.00	1.50	Soft to Dry rock		10.00	SPT	100	N > 100			Double Tube Core Barrel Used					Small Pieces Collected
10.00	11.50	1.50			11.50	SPT	100	N > 100			Double Tube Core Barrel Used					Small Pieces Collected
11.50	13.00	1.50			13.00	SPT	100	N > 100								Sample Collected
13.00	14.50	1.50			14.50	SPT	100	N > 100								Sample Collected
14.50	16.00	1.50			16.00	SPT	100	N > 100								Sample Collected
16.00	17.50	1.50	Rock		17.50		Double Tube Core Barrel Used				30	7		20		Sample Collected

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N 3/91, IRC Village, Bhubaneswar

BORE LOG DETAILS

Client : NTPC — Coordinates: E- 326173 N- 2615409

Project : Geotechnical Investigation Work for proposed main Plant and Ash Pond at PTPS Jharkhand. — Existing Ground Leve (m) : Refer Toppographical survey

Bore Hole No : BH-66 — Depth of Ground Water from EGL (in m) : 5.00

Location : Main Plant — Date of commencement : 22.01.2016

Type of Boring : Rotary Drilling — Date of Completion : 24.01.2016

Dia of Bore/ Sampler : 150mm in soil/Split Spoon Sampler/ 75mm in rock /Double Tube Core Barrel) — Conducted By : Rajaram Sahoo

Depth(m)		Length of Run (m)	Description of Strata	Log of Bore	Sampling		SPT				Details of Rock Core				
							Blows Required for Penetration of depth								
From	To				Depth	Type	0 - 15cm	15 - 30 cm	30- 45 cm	N value	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
17.50	19.00	1.50	Rock		19.00		Double Tube Core Barrel Used				41	8		27		Sample Colected
19.00	20.50	1.50			20.50		Double Tube Core Barrel Used				55	6	15 13	37	19	Sample Colected
20.50	22.00	1.50			22.00		Double Tube Core Barrel Used				43	7	15	29	10	Sample Colected
22.00	23.50	1.50			23.50		Double Tube Core Barrel Used				52	7	16	35	11	Sample Colected
23.50	25.00	1.50			25.00		Double Tube Core Barrel Used				43	5	15 10	29	17	Sample Colected

TABLE NO.- 18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

Sl No.	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY		PARTICLE SIZE(%)				CONSISTENCY PROPERTIES			IS CLASSIFICATION			SHEAR PARAMETERS				ONE DIMENSIONAL CONSOLIDATION		
				BULK (gm/cc)	DRY (gm/cc)	WATER CONTENT(%)	GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI (%)	GROUP LETTER SYMBOL	TYPICAL NAME	SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	Swell Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg/cm²)	TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (DEGREE)	Cc	Cv(cm²/min)	Volz Ratio
1	BH 1	2.5	UDS	1.99	1.72	15.27	4.38	35.41	22.72	35.49	32	17	15	CL	Gravelly Clay	2.68	11.19							0.155	0.536	0.562
		5.0	SPT											SM	Silty Sand with gravel	2.68										
2	BH 2	2.5	SPT	2.06	1.84	12.06	0.39	76.26	23.55		14	NP														0.411
3	BH 3	2.5	UDS	2.17	1.91	13.82	0	68.27	31.73		13	NP	–	SM	Silty Sand	2.57	Nil		Nil		UD	0.11	19			0.349
4	BH 4	2.5	SPT	2.02	1.77	14.16	17.59	51.12	20.41	10.59	20	NP	P	SM	Silty gravelly sand	2.58										0.461
		5.0	SPT											CI	inorganic silty clay of medium plasticity											
5	BH-5	2.5	SPT	2.03	1.83	10.93	0	12.68	31.53	55.79	28	20	18	SM	Sandy silt mixture	2.68					UD	0.03	21			0.288
		4.0	SPT																							
6	BH-6	2.5	SPT	1.98	1.70	16.53	2.52	28.61	32.53	36.35	29	16	13	CL	Gravelly sandy clay of low plasticity	2.67	6.2		70							0.521
		4.0	SPT																							
7	BH 7	2.5	SPT	2.41	1.92	17.51	0.25	71.88	18.31	9.56	21	NP		SM	Silty Sand	2.68	0.94									0.464
		5.0	SPT																							
8	BH 8	2.5	SPT	2.03	1.78	14.06	15.64	56.24	23.46	5.31	19	NP		SM												
		5.0	SPT																							
		7.5	SPT																							
9	BH 9	2.5	SPT	2.01	1.78	12.85	0	78.42	20.41	1.17	16	NP		SM	Silty Sand	2.66					UD	0.09	19			0.447
		5.0	SPT																							
10	BH 10	2.5	UDS	2.02	1.82	11.03	0	61.74	29.38	42.88	26	20	16	SM	Silty silty sand (Gravel	2.69	9.21		22		SPT	0.22	11			0.395
		4.0	SPT																							
		7.5	SPT																							
		10.0	SPT																							
		12.5	SPT																							
		15.0	SPT																							
		17.5	SPT																							
		20.0	SPT																							
		22.5	SPT																							
		25.0	SPT																							
		27.5	SPT																							
		30.0	SPT																							
		32.5	SPT																							
		35.0	SPT																							
		37.5	SPT																							
		40.0	SPT																							
		42.5	SPT																							
		45.0	SPT																							
		47.5	SPT																							
		50.0	SPT																							

TABLE NO.- 18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

Sl No	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY		WATER CONTENT(%)	PARTICLE SIZE(%)			CONSISTENCY PROPERTIES			IS CLASSIFICATION		TYPICAL NAME	SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	Swell Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg-cm²)	SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION			
				Bulk (gm/cc)	Dry (gm/cc)		GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	Group Letter Symbol								TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (f)(Degree)	Cc	Cv(cm2/min)	Void Ratio
11	44-11	4.0	SP			21.38	1.90	61.09	36.99	49.11	42	Np	TP	CL	Silty Sand with gravel	2.56											
12	34-12	4.0	SP	2.06	1.71	20.38	2.11	88.12	14.77		NP	NP		SM	Silty Sand with gravel	2.67											
		19.5	SP	1.97	1.72	14.73																					
13	34-13	1.5	SP					18.23	31.54	50.23	41	22			Silty clay of medium plasticity	2.68	4.73		28								
		3.0	SP	1.92	1.65	20.34		15.51	30.73	53.76	42	22															
14	44-14	3.5	SP					9.87	18.67	71.45	36	NP		SM	Silty Clayey Sand	2.67											
15	44-15	4.0	SP				1.79	84.56	10.76	4.89	16	NP		SM	Gravelly silty Sand												
16	34-16	4.0	SP					73.66	20.91	5.43	25	17		SM	Silty Sand	2.56											
17	44-17	5.5	SP	1.91	1.71	11.73	0.92	86.28	12.8		35	NP		SM	Silty Sand	2.56											
		9.5	SP					92.7	7.3		35	NP		SW-SM	Well graded silty sand												
18	34-18	1.0	SP	2.21	1.71	17.66		25.98	30.91	43.21	32	17		CL	Silty clay of low plasticity	2.68											
		2.5	SP	1.98	1.65	21.25		12.58	32.94	54.79	38	19		CI	Inorganic silty clay of medium plasticity				22								
19	44-19	5.5	SP					9.28	32.21						Gravelly silty sand												
20	44-20	2.5	SP	1.96	1.66	19.69	1.61	62.77	22.63	13.43	31	11		SM	Silty clay with gravel		4.42	0.042									
21	34-21	4.0	SP	1.93	1.79	11.25	0.32	72.25	22.37	4.56	16	NP		SM	Silty Sand	2.56											

TABLE NO.-18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

Sl no.	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY: BULK (gm/cc)	DENSITY: DRY (gm/cc)	WATER CONTENT (%)	PARTICLE SIZE (%): GRAVEL	SAND	SILT	CLAY	CONSISTENCY PROPERTIES: LL (%)	PL (%)	PI (%)	IS CLASSIFICATION: GROUP LETTER SYMBOL	TYPICAL NAME	SPECIFIC GRAVITY	SHRINKAGE LIMIT (%)	Swell Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined compressive Strength (kg/cm²)	SHEAR PARAMETERS: TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (θ) (Degree)	ONE DIMENSIONAL CONSOLIDATION: Cc	Cv (cm²/min)	Void Ratio
27	BH-25	5.5	SPT			15.04	0	83.32	0.81	16.68					Silty sand with clay	2.59										
28	BH-25	1.5	SPT	2.11	1.82	15.04	2.81	65.49	29.81	16.89				SC												
24	BH-26	4.5	SPT				5.45	76.23	18.11		16	NP		SM	Silty Sand with Gravel											
25	BH-26	4.5	SPT			13.71	0	56.59	28.33	16.19	23	18	5	SC	Clayey Silty sand with gravel	2.61										
26	BH-26	6.0	SPT	2.03	1.82	0.62	35.73	10.81	7.46					GC	Gravel	2.58										
27	BH-27	3.0	SPT	2.01	1.83	14.58	0	61.67	24.56	13.89	22	16	6	SC	Silty Sand with clay	2.58										
28	BH-27	4.5	SPT	2.07	1.79	11.85	0	88.08	11.92		18	NP		SM	Silty sand	2.56										
29	BH-28	6.0	SPT	2.11	1.85	12.17	10.54	54.61	18.72	16.12	17	NP		SM	Silty sand with gravel	2.57										
23	BH-29	3.0	SPT	1.93	1.72	12.28	4.13	80.04	9.72		17	NP		SW-SM	Gravelly sand with silt	2.57										
10	BH-30	3.0	SPT	2.16	1.94	11.97	0.84	87.44	11.72		16	NP		SM	Silty sand with gravel	2.56										
11	BH-30	4.5	SPT	2.19	1.91	14.71	0	76.29	24.31	39.41	29	17	12	CL	Clayey Silt	2.66	2.45									
12	BH-30	7.5	SPT				8.93	61.57	31.54						Gravelly sandy clay	2.56										
33	BH-35	6.0	SPT				8.64	76.28	21.43	39.65	31	18	13	CL	Gravelly clay of medium plasticity											
34	BH-35	7.5	SPT			13.76	0	86.83	13.5		17	NP		SM	Silty Sand	2.57										
32	BH-34	7.5	SPT	1.95	1.72	12.53	0	76.27	28.35	35.47	32	18	14	CL	Sandy silt Clay	2.66										
35	BH-35	6.0	SPT	1.95	1.72	12.81	0	95.0	5.2		16	NP		SP	Sand	2.56	Nil									

TABLE NO.- 18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

SL No.	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY		WATER CONTENT(%)	PARTICLE SIZE(%)			CONSISTENCY PROPERTIES			IS CLASSIFICATION		SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	Swell Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg/cm²)	SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION		
				BULK (gm/cc)	DRY (gm/cc)		GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI(%)	GROUP SYMBOL	TYPICAL NAME						TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION Ø(degree)	Cc	Cv(cm2/min)	Void Ratio
38	B-4/36	1.5	SPT	1.98	1.69	17.56	0.76	29.71	32.07	38.59	38	19	19	CL	Gravelly sandy clay of medium plasticity	2.67	5.58	0.139	22	2.36						
		3.0						29.46	66.4												UU	0.25	10	0.322	0.119	0.922
		4.5					1.18																			
39	B-4/38	1.5	SPT	2.01	1.81	14.51	2.73	29.96	18.51	0.8	18	9.9	8.1	SM	Silty Sand with gravel	2.66										
		3.0						38.51	22.59	38.91	31	17	14	CL	Sandy silt Clay											
40	B-4/40	1.5	SPT	2.02	1.69	19.71	0	22.56	49.64	27.8	38	20	18	CL	Sandy silty clay of medium plasticity	2.69	8.32		23							
		3.0						29.18	27.53	43.29	41	21	20			2.68										
		4.5																								
		10.5	SPT																							
41	B-4/41	1.5	SPT	1.92	1.72	11.74	3.41	89.64	9.5		19	9.7	9.3	SW-SM	Gravelly Sand with little fine	2.66					UU	0.38	23	0.459		
		3.0																								
42	B-4/42	1.5	SPT	2.02	1.76	14.86	0.5	29.67	36.81	33.02	31	15	16	CL	Gravelly Sandy Clay											
		3.0																								
43	B-4/43	1.5	SPT				7.29	63.52	21.01	7.78	22	16	6	SC	Gravelly silty Sand	2.67										
		3.0																								
		4.5																								
44	B-4/44	1.5	SPT	2.01	1.88	17.56	11.41	28.98	29.34	29.68	34	17	17	CL	Gravelly Clay	2.65	1.56				UU	0.28	16	0.431		
		3.0					12.66	18.47	28.01	40.88	34	17	17			2.69										
		4.5	SPT																							
45	B-4/45	1.5	SPT	2.21	1.93	14.73	5.4	40.16	26.39	29.06	29	16	13	CL	Gravelly sandy silty clay of low plasticity											
		3.0						62.51	5.2												UU	0.231	21			
		4.5	SPT				2.48							SC	Gravelly sand											

TABLE NO.-18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

SL NO	BOREHOLE NO	DEPTH (m)	TYPE OF SAMPLE	DENSITY		WATER CONTENT(%)	PARTICLE SIZE(%)			CONSISTENCY PROPERTIES			IS CLASSIFICATION						SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION		
				BULK (gm/cc)	DRY (gm/cc)		GRAVEL	SAND	SILT & CLAY	LL (%)	PL (%)	PI (%)	GROUP LETTER SYMBOL	TYPICAL NAME	SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	SWAM Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg/cm²)	TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (ϕ)(Degree)	Cc	Cv(cm2/min)	Void Ratio
46	BH-46	4.0	SPT	2.24	1.99	12.81	4.76	79.85	15.39	36	16	20	SW	Silty Sand with gravel						UU	0.28	36			
47	BH-47	4.0	SPT	2.16	1.95	23.72	3.56	44.73	51.71	50	15	35	CI	Sandy Clay with gravel		1.94	0.078								
48	BH-48	4.0	SPT				11.51	71.51	17.06				SW	Silty Sand with gravel											
49	BH-49	4.0	SPT				11.35	67.53	21.13				SW	Silty Sand with gravel											
50	BH-50	4.0	SPT				1.61	89.55	8.84				SW	Silty Sand with gravel											
		7.0	SPT				7.33	77.33	15.34				SW	Gravelly Sand with silt											
51	BH-51	2.5	UDS	1.98	1.67	18.86	0	16.83	83.17	53	31	22	CI	Silty Clay of medium plasticity		4.07				UU	0.28	14			
52	BH-52	2.5	UDS	1.97	1.68	17.41	2.46	29.62	67.92	51	20	31	CI	Silty Clay with gravel of medium plasticity		2.93		2.4		UU	0.26	12			
		7.0	SPT				3.13	89.35	7.52				SW	Silty Sand with gravel											
		4.0	SPT	1.99	1.82	18.41	4.27	15.91	79.82	53	16	37	CI	Silty Clay with Some Kankar											
53	BH-53	4.0	SPT	2.04	1.92	22.38	2.98	31.74	65.28	50	16	34	CI	Silty Sandy clay with gravel											
54	BH-54	5.5	SPT	2.03	1.72	18.74	8.54	21.76	69.70	53	17	36	CI	Silty Sandy Clay with gravel											
55	BH-55	5.5	SPT				2.58	89.25	8.17				SW	Gravelly Sand with fine											
56	BH-56	4.0	SPT	2.18	1.85	17.96	4.46	28.74	66.80	51	17	34	CI	Sandy Clay with gravel			0.11								
57	BH-57	4.0	SPT				2.91	31.56	65.53				SW	Silty Sand with gravel											
58	BH-58	4.0	SPT																						

TABLE NO.- 18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

SINo	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY		WATER CONTENT(%)	PARTICLE SIZE(%)				CONSISTENCY PROPERTIES			IS CLASSIFICATION		SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	Swell Pressure (kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg/cm²)	SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION		
				BULK (gm/cc)	DRY (gm/cc)		GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI (%)	GROUP LETTER SYMBOL	TYPICAL NAME						TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (DEGREE)	Cc	Cv(cm²/min)	Void Ratio
58	BH-63	1.0	SPT	2.06	1.91	14.01	5.52	25.71	21.81	46.96	34	15	18	CI	Gravelly sandy silty clay of low plasticity											
59	BH-63	1.5	SPT	2.09	1.86	21.47	0	29.83	31.81	38.36	46	17	29	CI	Silty Clay of medium plasticity											
60	BH-65	1.0	SPT												Gravelly Sand											
		4.0	SPT	1.99	1.76	12.96	1.84	91.66	6.5																	
61	BH 64	7.0	SPT				2.2	97.83	7.0						Gravelly Sand											
62	BH 65	1.0	SPT	2.02	1.81	11.96	3.93	86.66	9.5		17	NP	–	SW SM	Gravelly Sand with little fine											
63	BH 66	2.5	UDS	1.18	1.02	15.23	0	21.64	78.4		38	NP			Silt						UU	Nil	36			
		5.5	SPT				2.66	33.41	63.9						Clay Sand											
64	BH-67	4.0	SPT				10.76	21.73	28.36	39.65	35	15	17	CI	Gravelly sandy silty clay of low plasticity	2.68					UU	Not possible due to 4.75 size				
65	BH-68	2.5	UDS				0	15.81	29.37	54.82	41	22	19	CI	Silty sandy Clay of medium plasticity						SPT	0.41	8			
		4.0	SPT	1.99	1.66	19.61	0.79	22.83	26.21	50.79	38	20	18	CI		2.67	3.91		28							0.611

TABLE NO.-18

SUMMARY SHEET RESULT OF SOIL SAMPLES OF NTPC,RANCHI

Sl No	BOREHOLE NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY			PARTICLE SIZE(%)					CONSISTENCY PROPERTIES			IS CLASSIFICATION						SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION		
				BULK (gm/cc)	DRY (gm/cc)	WATER CONTENT(%)	GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI (%)	GROUP LETTER SYMBOL	TYPICAL NAME	SPECIFIC GRAVITY	SHRINKAGE LIMIT(%)	Swell Pressure (Kg/cm²)	FREE SWELL INDEX (%)	Unconfined Compressive Strength (kg/cm²)	TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (degree)	Cc	Cv(cm2/min)	Void Ratio
67	BH-70	4.0	SPT	1.98	1.55	16.93	7.88	34.41	25.73	36.98	32	16	16	CL	Silty sandy clay with gravel	2.69	1.81				UU	Not possible				
68	BH-71	3.0	SPT	1.98	1.67	18.67	5.26	41.69	21.76	31.01	29	13	16	CL	Silty sandy clay with gravel	2.67										
69	BH-72	4.0	SPT	1.93	1.62	14.62	4.36	34.56	25.73	35.35	31	14	17	CL	Silty sandy clay with gravel	2.66										
		7.0	SPT				2.39	59.16	21.58	21.97	22	5	17	SC	Silty sand with clay											
70	BH-73	4.0	SPT	1.98	1.65	20.41	1.85	34.84	26.31	37	30	12	18	CL	Sandy Clay	2.67										
71	BH-74	4.0	SPT	1.94	1.62	19.86	2	8.71	28.64	61.35	46	23	23	CI	Silty Clay of medium plasticity	2.67										
		5.5	SPT				10.19	23.16	26.81	39.84	37	15	22	CL			3.96									
72	BH-75	5.5	SPT	1.98	1.65	17.21	6.38	22.57	28.28	42.87	35	16	19	CL	Clayey sandy silty clay intermediate plasticity	2.69			18		UU	Not possible				

TABLE NO-19

SUMMARY RESULT OF ROCK CORE SAMPLES OF NTPC,RANCHI

Sl No	BH No	Depth (m)	Density (gm / cc)		Moisture Content (%)	Porosity (%)	Specific Gravity	Unconfined Compressive Strength (t/ m^2)		Soundness in %		Slake Durability Index	Point Load t/m^2	Hardness (as per Mohs' Scale)
			Bulk	Dry				Dry	Saturated	Na_2So_4	Mg_2So_4			
1	BH-1	16.5	1.84	1.77	3.86	41.28	1.969	958.73	842.19				33.68	
2	BH-2	9.0	2.65	2.62	1.18	28.32	3.034	3840.51	3628.25				145.13	
		12.0	2.54	2.51	1.23	30.27	2.992	1467.38	1272.72				50.90	
3	BH-3	20.5	2.75	2.72	0.98	29.46	3.113	1636.36	1825.28				65.45	
		28.0	2.57	2.54	1.31	30.18	3.033	4328.71	4128.53				165.14	
4	BH-4	8.5	2.41	2.34	2.86	21.48	2.78	661.53	603.28	4.3	2.8	22.80	30.164	
		28.0	2.36	2.33	1.43	16.36	2.83	1186.22	1008.55				50.425	
5	BH-5	21.0	2.52	2.47	1.98	28.56	2.81	2156.21	1938.66			18.73	95.62	*
6	BH-6	12.5	2.6	2.56	1.39	22.31	2.83	2391.57	2241.25	5.3	11.47		104.31	
7	BH-7	17.0	2.38	2.33	2.22	28.27	2.88	1437.38	1203.84				60.21	
8	BH-9	25.5	2.72	2.67	1.98	28.71	3.114	1903.51	1764.71			19.73		*
9	BH-10	19.0	2.83	2.82	0.52	14.81	2.91	1891.46	1637.43	3.7	2.4	14.2	81.87	
10	BH-11	21.0	2.69	2.64	1.87	25.86	3.21	3185.28	2941.83	5.33	8.81	16.81	143.18	
		25.5	2.63	2.59	1.72	24.91	3.24	4374.46	3898.71	4.84	7.37			*
11	BH-14	30.0	2.54	2.49	1.88	26.28	3.117	3026.57	2893.63					
12	BH-15	18.0	2.55	2.53	0.68	22.63	3.11	5783.28	3896.81			14.33	260.88	*
		21.0	2.60	2.58	0.61	21.87	3.14	6030.71	4221.93				269.86	

TABLE NO-19

SUMMARY RESULT OF ROCK CORE SAMPLES OF NTPC,RANCHI

Sl No	BH No	Depth (m)	Density (gm/cc)		Moisture Content (%)	Porosity (%)	Specific Gravity	Unconfined Compressive Strength (t/m²)		Soundness in %		Slake Durability Index	Point Load t/m²	Hardness [as per Mohs' Scale]
			Bulk	Dry				Dry	Saturated	Na_2So_4	Mg_2So_4			
13	BH-16	22.5	2.58	2.53	1.91	27.33	3.114	2891.54	2644.86	5.17	6.73		130.4	*
		25.5	2.68	2.66	0.83	18.71	3.306	3018.61	2831.77					
14	BH-17	26.5	2.49	2.47	0.73	22.91	3.09	5493.37	3681.41	4.93	7.82		247.7	*
		30.0	2.53	2.51	0.68	22.86	3.1	5661.53	3873.29			15.16	255.34	*
15	BH-19	18.0	2.29	2.24	2.36	44.37	2.691	901.28	831.57			53.81	18.26	
16	BH-21	24.0	2.73	2.70	1.28	19.78	2.97	1831.41	1565.22				76.71	
17	BH-23	19.5	2.63	2.60	1.24	21.84	2.82	1853.44	1796.61	4.9	11.21	24.37	84.07	.
18	BH-25	7.0	2.52	2.48	1.43	24.57	2.74	1804.73	1661.53				81.83	
19	BH-26	25.5	2.66	2.63	1.05	22.64	2.86	2964.33	2486.51	3.76	6.84	14.31	118.38	*
20	BH-29	7.0	2.51	2.47	1.72	29.24	2.93	2188.57	1996.73	4.81	9.26	15.83	93.81	*
		22.0	2.48	2.44	1.81	31.61	2.91	2104.66	1583.71				81.73	
21	BH-34	11.0	2.53	2.49	1.63	30.73	2.88	1884.28	1643.83			21.73	80.58	
		23.0	2.49	2.45	1.58	29.58	2.86	1903.51	1786.28				89.27	
22	BH-36	9.0	2.51	2.48	1.39	30.72	2.83	1944.26	1809.71				88.28	
		12.0	2.53	2.49	1.41	28.49	2.84	1889.41	1756.38	6.41	10.28	20.92	77.53	*
23	BH-38	18.0	2.61	2.57	1.43	27.64	2.81	1921.28	1830.41				86.64	
24	BH-39	9.0	2.58	2.54	1.54	26.81	2.84	1894.53	1732.44			20.64	76.53	
		13.5	2.57	2.53	1.46	25.93	2.86	1906.72	1831.32				84.91	

TABLE NO-19

SUMMARY RESULT OF ROCK CORE SAMPLES OF NTPC,RANCHI

Sl No	BH No	Depth (m)	Density (gm/cc)		Moisture Content (%)	Porosity (%)	Specific Gravity	Unconfined Compressive Strength (t/m^2)		Soundness in %		Slake Durability Index	Point Load t/m^2	Hardness (as per Mohs' Scale)
			Bulk	Dry				Dry	Saturated	Na_2So_4	Mg_2So_4			
25	BH-55	23.0	2.43	2.41	0.81	24.21	2.99	5344.82	3997.57	5.21	8.47	14.28	238.95	
26	BH-56	7.5	2.56	2.54	0.66	21.99	3.14	6884.31	4383.74				309.92	
		10.5	2.54	2.52	0.67	20.83	3.13	7089.43	5637.28				321.47	
27	BH-57	20.0	2.52	2.50	0.73	22.41	3.11	6781.28	4893.41				306.24	
28	BH-60	7.0	2.53	2.51	0.68	21.86	3.13	5003.84	3957.24				225.45	
		10.0	2.54	2.52	0.7	20.99	3.16	4981.29	3332.71	5.33	7.94		220.43	*
		11.0	2.52	2.50	0.63	19.76	3.13	5063.96	4193.28				224.18	
29	BH-63	11.5	2.46	2.44	0.71	20.23	3.18	3821.17	2483.53	4.56	8.39	13.43	171.69	
		14.5	2.53	2.51	0.68	20.62	3.09	3935.43	2686.22			12.81	173.2	*
30	BH-64	15.0	2.44	2.42	0.72	21.41	3.05	3641.77	2197.83	5.28	8.19	12.64	163.47	
		16.5	2.41	2.39	0.68	20.89	3.12	4118.36	3028.19				182.34	
31	BH-65	7.0	2.51	2.49	0.63	19.73	3.09	4911.72	3121.76	4.38	6.93		220.26	*
		10.0	2.53	2.51	0.62	19.81	3.13	7884.43	5934.81			11.92	355.38	*

SUMMARY SHEET RESULT OF PIT SOIL SAMPLES OF NTPC,RANCHI

SL NO.	PIT NO	DEPTH (m)	TYPE OF SAMPLE	DENSITY		WATER CONTENT(%)	PARTICLE SIZE(%)				CONSISTENCY PROPERTIES			SOIL			PERMEABILITY TEST cm/s				SHEAR PARAMETERS				ONE DIMENSIONAL CONSOLIDATION	
				BULK (gm/cc)	DRY (gm/cc)		GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI (%)	IS CLASSIFICATION	DESCRIPTION	SPECIFIC GRAVITY	FREE SWELL INDEX (%)	D% BENTONITE MIX	2% BENTONITE MIX	4% BENTONITE MIX	6% BENTONITE MIX	TYPE OF TEST	COHESION IN (kg/cm²)	ANGLE OF INTERNAL FRICTION (DEGREES)	Cc	Cv(CM2/min)	Void Ratio

TABLE NO-20

SUMMARY SHEET RESULT OF PIT SOIL SAMPLES

Sl No	PIT NO.	DEPTH (m)	DENSITY			PARTICLE SIZE(%)			CONSISTENCY PROPERTIES			SOIL		SPECIFIC GRAVITY	FREE SWELL INDEX (%)	PERMEABILITY TEST cm/s				SHEAR PARAMETERS			ONE DIMENSIONAL CONSOLIDATION		
			TYPE OF SAMPLE	BULK (gm/cc)	DRY (gm/cc)	WATER CONTENT(%)	GRAVEL	SAND	SILT	CLAY	LL (%)	PL (%)	PI (%)	IS CLASSIFICATION	DESCRIPTION			0% Bentonite blen	2% Bentonite blen	4% Bentonite blen	6% Bentonite blen	TYPE OF TEST	COHESION IN (Kg/cm^2)	ANGLE OF INTERNAL FRICTION (Ø)Degree	Cv	Cv(cm2/min)	Void Ratio
1		1.0	UDS	2.07	2.00	13.81	3.33	36.82	22.64	40.22	31	19	12	CL		2.62	8						UU	0.19	8	0.188	0.0026	0.548
		2.0	UDS	1.99	1.75	14.33	3.78	49.44	21.87	24.87	28	20	8	CI	Clayey Soil	2.66	8						UU	0.14	7.9	0.164	0.0024	0.5024
		3.0	UDS	2.02	1.78	16.86	3.56	40.39	24.22	31.83	30	20	10	CI		2.66	8						UU	0.19	7.9	0.168	0.0027	0.5439
		1.0	UDS	2.06	1.86	10.96	0.28	33.82	28.74	37.18	30	24	6	CI	Clayey Soil	2.67	12						UU	0.21	8.2	0.222	0.0028	0.5382
6		2.0	UDS	2.07	1.87	10.72	1.34	28.43	33.75	36.05	36	25	11	CI	Clayey Soil	2.68	12						UU	0.22	8.5	0.22	0.0027	0.5164
		4.0	UDS	2.05	1.85	10.72	1.88	43.09	29.47	25.57	41	25	16	CI		2.64	12						UU	0.24	7.8	0.214	0.0029	0.4967
		1.0	UDS	2.06	1.89	9.03	2.04	37.58	32.46	27.92	32	17	15	CI		2.66	8						UU	0.22	9	0.218	0.0024	0.5227
		2.0	UDS	2.03	1.86	10.83	4.36	42.64	30.53	22.47	38	20	18	CI	Clayey Soil	2.66	6						UU	0.18	7.9	0.164	0.0023	0.5516
		3.0	UDS	2.02	1.84	10.86	3.82	36.82	30.85	28.51	39	20	19	CL		2.62	6						UU	0.19	7.9	0.192	0.0021	0.5456

8.8 CHEMICAL TESTS ON GROUND WATER AND SUBSOIL SAMPLES:

8.8.1 Chemical analysis of the ground water samples have been done to determine the pH value, turbidity, total hardness, sulphate, chloride, carbonate, organic matter, total dissolved solid, total alkalinity as $CaCO_3$ & nitrite as NO_3 contents and Standard procedure has been followed for conducting these tests.

TABLE NO - 21

SUMMARY OF CHEMICAL TEST ON GROUND WATER SAMPLES

PARAMETERS	RESULTS				
Water Sample	BH-7	BH-12	BH-20	BH-27	BH-72
pH @ 25°C	7.5	7.6	7.8	7.7	7.8
Total Hardness as $CaCO_3$ (mg/l)	58	66	120	124	130
Sulphate as SO_4 (mg/l)	35.7	37	36.4	43.9	29.5
Chloride as Cl (mg/l)	33	18	20	33	10
Carbonate as $CaCO_3$ (mg/l)	100	100	170	170	180
Organic Matter (mg/l)	11.4	10.8	12.3	12.0	11.22
Total Dissolved Solid (mg/l)	280.4	291.0	341.2	315.1	370.8
Total Alkalinity as $CaCO_3$ (mg/l)	100	100	170	170	180
Nitrate as NO_3 (mg/l)	1.2	1.0	1.1	1.3	1.5

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ıry Geotechnical Investigation Work for Proposed Main Plant and Ash Pond at PTPS Jharkhand.

ɜmical analysis of the subsoil samples have been done to determine the pH value, Sulphate, Carbonate, Organic matter & nitrite contents and Standard procedure has been followed for g these tests.

TABLE NO - 22

SUMMARY OF CHEMICAL TEST ON SUBSOIL SAMPLES

Sl. No.	RESULTS				
SOIL SAMPLE	BH-12	BH-28	BH-37	BH-47	BH-68
@ 25°C (1:10)	7.4	7.6	7.5	7.2	7.6
ɜe as SO_4 (mg/kg)	125	115.0	120.4	140.1	100.1
ɗe as Cl (mg/kg)	276	280	282	300	250
ɜnate as $CaCO_3$ (mg/kg)	47	42	48	50	50
ɜnic Matter (%)	18.24	24.5	25.1	22.41	53.22
as NO_3 (mg/kg)	17.4	21.0	19.23	19.0	17.2

suggested that the quality and quantity of cement to be used for construction of foundation ɜ coming in contact with subsoil/ ground water may be decided taking in to account the and chloride content as indicated above and as per the provisions of Clauses 8.2.2.4 and 9.1.2 2000.

ANNEXURE- (d)

CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures shall be designed for wind forces in accordance with IS 875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than "5" and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS 875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures : 1.6%

d) Steel stacks : As per IS 6533 & CICIND Model Code whichever is more critical.

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "V_b" at ten metre above the mean ground level: 39 metre/second

b) The risk coefficient "K_1" : 1.06

c) Category of terrain : Category-2

Annexure-(E)

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

Refer Annexure- 2 for detail

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1):2002 and IS:1893 (Part 4):2005. Pending finalization of Parts 2, 3 and 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for structures other than the buildings and industrial structures including stack-like structures.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Annexure-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Annexure-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 and Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

Steel structures	2 %
Reinforced Concrete structures	5 %
Reinforced Concrete Stacks	3 %
Steel stacks	2 %

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

For buildings, if the design base shear (VB) obtained from modal combination is less than the base shear ($\bar{V}B$) computed using the approximate fundamental period (Ta) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}B$/ VB. However, no reduction is permitted if $\bar{V}B$ is less than VB.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Annexure-I. Further, the spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the building falls to the left of the peak in the spectral acceleration curve.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The site specific seismic parameters for the project site shall be furnished later.

Annexure-(f)

QA REQUIREMENT

All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of this Specification.

Annexure-(g)

RAINFALL DATA

For Rain fall data refer Meteorological Data indicated in project information Sub-Section-IB in Part-A.

ANNEXURE - H

Specification For High Performance Moisture Compatible Corrosion Resistant Coating System

a) Providing & applying **High Performance Moisture Compatible Corrosion Resistant Coating System** manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.I.R. affiliate Institute), Tamil Nadu, Pin - 630 006.

b) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

Annexure-(i)

List of tender drawings attached with this specification include

Sl No.	Title	Drg No.
1)	General Layout Plan	9585-999-POC-F-001-Rev 4
2)	Site Levelling Works	9585-001-POC-A-001-Rev D
3)	Topographical Survey Detail	9585-001-PVC-F-002-RevA
4)	Owner's Construction Office	9585-001-POC-A-002-Rev-A
	Safety Park Architectural Details and specifications	9585-001-POC-A-005- REV-A
	Typical Layout of Make up water pipeline	9585-001-POC-A-006-Rev-A
	Typical Details of Make up water pipeline Crossings	9585-001-POC-A-007-Rev-B

Annexure-(J)

ELECTRICAL RESISTIVITY DATA

Preliminary Geotechnical Investigation Work for Proposed Main Plant and Ash Pond at PTPS Jharkhand

TABLE NO - 15

Depth (m)	ERT 01	ERT 02	ERT 03	ERT 04	ERT 05	ERT 06	ERT 07	ERT 08	ERT 09	ERT 10
0.5	18.13	21.53	147.11	223.05	213.65	303.24	1862.96	131.85	180.75	17.12
1	20.48	25.43	116.33	205.50	173.20	235.47	677.01	131.95	164.46	20.31
2	11.08	25.79	99.22	190.86	142.64	205.47	376.47	122.98	132.17	16.83
3	10.10	22.58	78.15	159.75	129.53	262.59	386.96	113.74	128.83	18.29
4	10.59	17.36	69.24	138.08	117.84	253.84	317.45	106.04	140.78	19.98
5	11.66	16.81	56.74	122.59	104.12	274.81	238.13	87.24	159.04	21.56
6	12.14	18.12	51.36	139.91	110.59	311.52	126.41	81.75	174.96	23.10
7	12.69	9.57	47.95	146.15	104.56	308.88	227.06	58.98	169.46	24.08
8	11.95	10.09	44.25	115.79	100.72	310.53	223.05	53.91	152.19	25.49
9	13.06	9.87	43.31	132.89	87.74	335.44	243.87	42.69	148.58	29.89
10	13.05	10.39	43.28	129.15	84.56	327.96	233.41	35.84	132.45	28.24

TABLE NO - 16

Depth (m)	ERT 11	ERT 12	ERT 13	ERT 14	ERT 15	ERT 16	ERT 17	ERT 18	ERT 19
0.5	35.07	235.93	321.39	106.62	43.73	234.12	314.31	302.85	304.34
1	39.53	171.94	295.01	97.39	35.78	231.72	224.94	274.24	282.05
2	43.79	129.90	262.44	42.49	34.77	226.58	154.84	241.55	266.75
3	50.78	123.55	256.21	32.36	31.71	194.83	109.17	237.81	235.43
4	57.01	119.66	216.42	27.25	30.79	174.13	85.26	153.60	227.80
5	60.59	138.55	218.34	30.77	24.64	142.84	85.54	128.28	214.96
6	63.06	154.84	185.62	32.99	21.53	111.79	80.77	127.23	191.01
7	61.19	152.40	154.04	36.14	20.10	105.05	78.66	143.73	179.71
8	64.74	139.94	114.46	37.70	18.35	100.60	69.00	128.60	159.00
9	65.05	123.46	62.44	38.29	20.11	88.36	61.39	124.21	137.50
10	66.86	118.68	51.05	41.07	19.76	74.24	50.67	109.91	140.00

ARKITECHNO

ARKI TECHNO
CONSULTANTS (INDIA) PVT LTD

ELECTRICAL RESISTIVITY TEST:-

The Electrical Resistivity Tests have been conducted at 19 proposed sites as per list below (***Table-1***) along two perpendicular lines in both North-South and East-West direction at each site using Werner's four electrode methods specified in IS:1892, Appendix-B2. On each line 11 readings have been taken by changing the spacing of the electrodes from 0.5m up to a distance of 10m.

***Table-1*: ERT SITES**

Sl. No.	Site Id	Coordinates	
1	ERT-01	N2615944	E325421
2	ERT-02	N2616080	E325302
3	ERT-03	N2616088	E325465
4	ERT-04	N2616033	E325579
5	ERT-05	N2616220	E325576
6	ERT-06	N2616165	E325660
7	ERT-07	N2616165	E325695
8	ERT-08	N2616165	E325695
9	ERT-09	N2616166	E325716
10	ERT-10	N2616450	E325790
11	ERT-11	N2616014	E-325991
12	ERT-12	N2616338	E-326131
13	ERT-13	N2615650	E-325208
14	ERT-14	N2615461	E-325165
15	ERT-15	N2615358	E-324950
16	ERT-16	N2615171	E 325514
17	ERT-17	N2614851	E325623
18	ERT-18	N2617335	E325758
19	ERT-19	N2615341	E326174

TABLE NO - 15

Depth (m)	ERT 01	ERT 02	ERT 03	ERT 04	ERT 05	ERT 06	ERT 07	ERT 08	ERT 09	ERT 10
0.5	18.13	21.53	147.11	223.05	213.65	303.24	1862.96	131.85	180.76	17.12
1	20.48	25.43	116.33	205.50	173.20	235.47	677.01	131.95	164.46	20.31
2	11.08	25.79	99.22	190.86	142.64	205.47	376.47	122.98	132.17	16.83
3	10.10	22.58	78.15	159.75	129.53	262.59	386.96	113.71	128.83	18.29
4	10.59	17.36	69.24	138.08	117.84	253.84	317.45	106.04	140.78	19.98
5	11.66	16.81	56.74	122.59	104.12	274.81	238.13	87.24	159.04	21.56
6	12.14	18.12	51.36	139.91	110.59	311.52	126.41	81.75	174.96	23.10
7	12.69	9.57	47.95	146.15	104.56	308.88	227.06	58.98	169.46	24.08
8	11.95	10.09	44.25	115.79	100.72	310.53	223.05	53.91	152.19	25.49
9	13.06	9.87	43.31	132.89	87.74	335.44	243.87	42.69	148.58	29.89
10	13.05	10.39	43.28	129.15	84.56	327.96	233.41	35.84	132.45	28.24

TABLE NO - 16

Depth (m)	ERT 11	ERT 12	ERT 13	ERT 14	ERT 15	ERT 16	ERT 17	ERT 18	ERT 19
0.5	35.07	235.93	321.39	106.62	43.73	234.12	314.31	302.85	304.34
1	39.53	171.94	295.01	97.39	35.78	231.72	224.94	274.24	282.05
2	43.79	129.90	262.44	42.49	34.77	226.58	154.84	241.55	266.75
3	50.78	123.55	256.21	32.36	31.71	194.83	109.17	237.81	235.43
4	57.01	119.66	216.42	27.25	30.79	174.13	85.26	153.60	227.80
5	60.59	138.55	218.34	30.77	24.64	142.84	85.54	128.28	214.96
6	63.06	154.84	185.62	32.99	21.53	111.79	80.77	127.23	191.01
7	61.19	152.40	154.04	36.14	20.10	105.05	78.66	143.73	179.71
8	64.74	139.94	114.46	37.70	18.35	100.60	69.00	128.60	159.00
9	65.05	123.46	62.44	38.29	20.11	88.36	61.29	124.21	137.50
10	66.86	118.68	51.05	41.07	19.76	74.24	50.67	108.91	140.00

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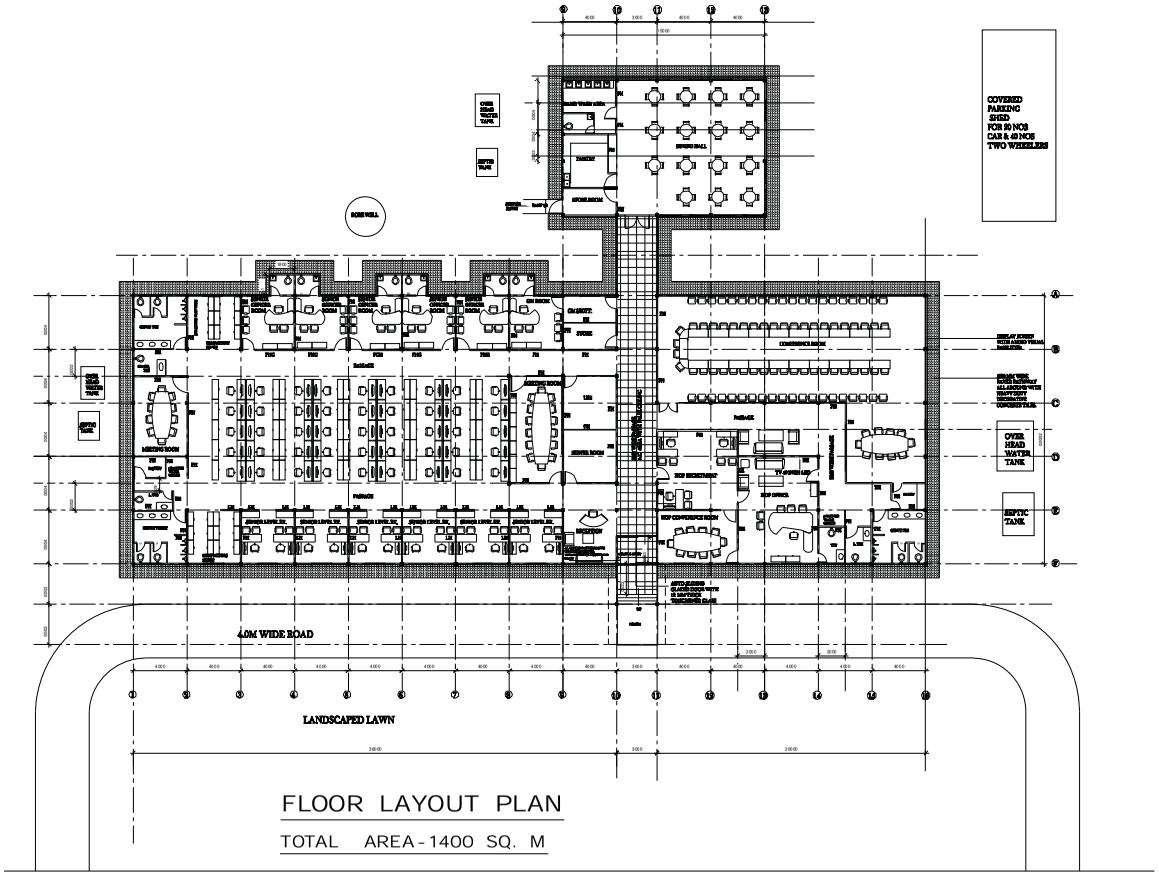

FLOOR LAYOUT PLAN

TOTAL AREA - 1400 SQ. M

FOR TENDER PURPOSE ONLY

LEGEND:

1. FH- FULL HEIGHT CABIN WITH MODULAR PARTITION FOR AGM / GM (06 NOS)
2.FHG- FULL HEIGHT CABIN WITH MODULAR PARTITION & TOUGHENED 6 MM THICK ETCHED GLASS ABOVE 1 900 HIGH OPAQUE PARTITION
3. LH - LOW HEIGHT (1 350 MM) CABINS WITH MODULAR PARTITION FOR SR. MANAGER / DGM (12 NOS)
4. WS - WORK STATION S FOR EI TO E5 (4 5 NOS)
5. SC- STORAGE CABINETS LOW HEIGHT (1200 MM)
6. WSP- WORK STATION PARTITION 1350 MM HIGH
7. HOP - HEAD OF PROJECT FULL HEIGHT CABIN 1 NO.
8. HOP SECRETARIAT FULL HEIGHT CABIN 3 NOS

OWNER'S CONSTRUCTION OFFICE

THIS BUILDING SHALL BE A SINGLE STOREYED BUILDING WITH FLOOR AREA OF 1400 SQ. M OF PRE-ENGINEERED BUILDING WITH STEEL FRAME CONSTRUCTION, WITH MINIMUM FLOOR TO ROOF HEIGHT 4 .25M AND INSULATED SANDWICH CLADDING FOR WALLS AND SANDWICHED METAL SHEET ROOFING. THE DESIGN OF THE BUILDING SHALL BE SUCH SO AS TO HAVE FASTER CONSTRUCTION OF BUILDING AND SO AS TO PROVIDE A READY TO USE BUILDING, COMPLETE AND FINISHED IN ALL RESPECTS TO THE OWNER. THIS BUILDING SHALL PROVIDE OFFICES SENIOR OFFICERS, CONFERENCE ROOMS LARGE OFFICE HALLS WITH LAYOUT AND OCCUPANCY AS SHOWN IN THE DRAWING.

SCOPE OF WORK

1. DESIGNING, MANUFACTURING, SUPPLY, PACKING, LOADING TRANSPORTATION, UNLOADING, INSTALLING AND COMMISSIONING THE PRE-FABRICATED PORTABLE, DETACHABLE, DOUBLE LAYER INSULATED PORTA CABINS, SANDWICHED METAL SHEET ROOFING, EAVES GUTTER & RAIN WATER DOWN COMER. AS PER LAYOUT SHOWN INCLUDING FOUNDATIONS, SUBSTRUCTURES AND SUPER STRUCTURES AND ALL FINISHING, COMPLETE IN ALL RESPECTS.

2. MAIN MS FRAME WITH MS STANDARD BRACING WITH VERTICAL AND HORIZONTAL GRIDS WITH DIPPED ANTI- CORROSIVE COATINGS BE GROUTED TO R.C.C FLOOR / PLATFORM. THE PLINTH SHALL BE 500 MM HIGH WITH PERIPHERAL R.C.C WALL AND 100 MM THICK P.C.C

3.SANDWICHED METAL SHEET FOR ROOFING CONSISTING OF TOP SHEET AS TROUGHED PERMANENTLY COLOUR COATED SHEET & BOTTOM SHEET AS PLAIN PERMANENTLY COLOUR COATED FOR COVERING OF EXPOSED METAL/ CONCRETE/ BRICK SURFACES WITH 50MM THICK INSULATION SANDWICHED BETWEEN THE TWO SHEETS, EACH SHEET SHALL BE OF STEEL WITH ZINC COATED TO CLASS 275 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.6MM OF GRADE G250 AS PER AS 1397 / GRADE S255 AS PER ASTM A653M / GRADE S250GD AS PER EN 10326 OR OF STEEL WITH ALUMINUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.5MM OF GRADE G350 AS PER AS 1397 / GRADE S340 CLASS 4 AS PER ASTM A792M / GRADE S350GD AS PER EN 10326 OR OF STEEL WITH ALUMINUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.4MM OF GRADE G550 AS PER AS 1397 / GRADE S550 AS PER ASTM A792M / GRADE S550GD AS PER EN 10326

4. WALL CLADDING SHALL CONSIST OF AN OUTER WALL OF HALF HOUR FIRE RATED ,10 MM THICK SILICA FIBER BOARD CLADDING(100 % ASBESTOS AND TERMITE FREE, WITH DENSITY > 1200 KG/ SQ. M) FIXED OVER STEEL GRID BY SELF THREADED STUDS / PASTED WITH UNDER WATER ITALIAN EPOXY AND INTERNAL WALL SHALL BE 12.5MM THICK GYPSUM BOARD CONFIRMING TO IS:2095 PART-I FINISHED WITH ACRYLIC EMULSION PAINT OF DULUX / ASIAN/ NEROLAC OR EQUIVALENT THE EDGE OF THE BOARD SHALL BE PROPERLY SEALED WITH PU HIGH EPOXY AND STANDARD CHANNELS WHEREVER REQUIRED. INSULATION OF GLASS WOOL (DENSITY 32 KG/CU. M) UPTO 50 MM NOMINAL THICKNESS SHALL BE PROVIDED IN BETWEEN OUTER AND INTERNAL CLADDINGS AND WICHED WALL CLADDING SHALL BE FINISHED ON OUTER SIDE WITH 4MM THICK ALL COMPOSITE PANEL SHEET.

5 . DOOR & WIN DOWS SHALL BE PROVIDED AS PER THE LAYOUT SHOWN WITH MINIMUM WINDOW AREA OF 20 % OF THE CARPET AREA, POWDER COATED ALL FARMES WITH MINIMUM WALL THICKNESS OF 2 MM FOR DOOR WINDOWS & VENTILATORS WITH 24 MM THICK HERMETICALLY SEALED DOUBLE GLAZING WITH TOUGHENED GLASS FOR WINDOWS AND 8 MM THICK TOUGHENED GLASS FOR GLAZED DOORS. MAIN ENTRANCE DOOR SHALL BE GLAZED AUTO SLIDING DOOR. FOR TOILETS & PANTRIES DECORATIVE TYPE LAMINATED FLUSH DOOR SHUTTER SHALL BE PROVIDED. ALL THE NECESSARY ACCESSORIES AND HARDWARE SHALL BE PROVIDED. VERTICAL VENETIAN BLINDS IN PREMIUM FABRIC QUALITY SHALL BE PROVIDED FOR ALL THE WINDOWS.

6. FALSE CEILING IN PERFORATED ALUMINIUM TILES / PLANKS OF ARMSTRONG/ HUNTER DOUGLAS OR EQUIVALENT WITH ACOUSTICAL FLEECE ABOVE SHALL BE PROVIDED IN THE ENTIRE BUILDING.

7 MIRROR POLISHED VITRIFIED TILE FLOORING (SIZE 800MM X 800MM) OF KAJARIA / JHONSON MAKE SHALL BE PROVIDED FOR OFFICE AREAS. FOR CONFERENCE ROOM LAMINATED WOODEN FLOORING SHALL BE PROVIDED. FOR SENIOR OFFICER ROOM PREMIUM QUALITY CARPET FLOORING SHALL BE PROVIDED. DUST PRESSED CERAMIC TILES FLOORING SHALL BE PROVIDE FOR TOILETS & PANTRIES / KITCHEN WITH DESIGNER DECORATIVE CERAMIC TILE ON WALL CLADDING UPTO FALSE CEILING SHALL BE PROVIDED.

8. ALL THE PARTITIONS AS PER THE LAYOUT - FULL HEIGHT / LOW HEIGHT BASED ON MODULAR PARTITION DESIGN OF GODREJ / JASANI OR EQUIVALENT SHALL BE PROVIDED

9. ALL THE FURNITURE AS SHOWN INCLUDING MODULAR WORK STATIONS, EXECUTIVE CHAIRS&TABLES, CONFERENCE TABLES, STORAGE / COMPACTORS, VISITOR CHAIRS, SOFAS, RECEPTION TABLE, DINING TABLE & CHAIRS ETC OF GODREJ / HEATHERLITE / JASANI OR EQUIVALENT SHALL BE PROVIDED.

10. ALL THE TOILETS IN WORKING CONDITIONS INCLUDING MALE & FEMALE TOILETS, HANDICAPPED TOILET, ATTACHED TOILETS, WASH ROOMS, PANTRY / KITCHEN COMPLETE IN ALL RESPECTS WITH SENSOR BASED WASH BASIN SET IN GRANITE COUNTERS, SENSOR BASED URINALS, DUAL FLUSH WALL HUNG W.C WITH SENSOR BASED TAPS OF JAGUAR OR EQUIVALENT. ALL THE NECESSARY ACCESSORIES OF PREMIUM QUALITY SHALL BE PROVIDED.

11 .INTELLIGENT AND ENERGY EFFICIENT LED LIGHTING WITH MINIMUM LUX LEVEL AS MENTIONED BELOW WITH RECESSED OPTIC LUMINARIES / LED DOWN LIGHTERS/ PENDANT LIGHT/ ASCENT LIGHT OF PHILIPS W PROJ CROMPTON GREAVES/ HAVELL OR EQUIVALENT, COMPLETE IN ALL RESPECTS WITH ASSOCIATED CABLING, FIXTURES LIKE FANS , SWITCHES, MCB, ENERGY MANAGEMENT SYSTEM LIKE DIMMERS /SENSORS ETC.
a)OFFICES, CONFERENCE ROOM ETC.- 300 LUX , DECORATIVE MIRROR OPTIC TYPE LED LUMINARIES OR LED DOWN LIGHTER
b)CAR PARKING - 50 LUX , INDUSTRIAL TYPE LED LUMINARIES .
c) CANTEEN - 150 LUX , INDUSTRIAL TYPE LED LUMINARIES .
d) CORRIDOR / PASSSAGE: 50 LUX , LED LUMINARIES
e) BUILDING PERIPHERY LIGHTING :- 50 LUX , LED LUMINARIES / LED STREET LIGHT FIXTURES.
f)OTHER AREAS NOT COVERED ABOVE :- LIGHTING PRINCIPLES SHALL BE BASED AS MENTIONED ABOVE

12. THE BUILDING SHALL BE COMPLETELY AIR-CONDITIONED BUILDING. SPLIT A.C SHALL BE PROVIDED FOR OFFICE CABINS AND CASSETTE TYPE AIR - CONDITIONERS FOR CONFERENCE ROOM, HOP OFFICE AND WORK STATION AREA. CAPACITY OF THE A.C SYSTEM SHALL BE @ 1 TON PER 10 SQ.M CARPET AREA AND A.C EQUIPMENT SHALL CONFORM TO 4 STAR RATING OF BEE AND SHALL BE OF LG/ VOLTAS/ BLUE STAR/ HITACHI OR EQUIVALENT MAKE.

13 .FIRE DETECTION AND FIRE FIGHTING SYSTEM COMPLETE IN ALL RESPECT.

14. COMPLETE CONCEALED CABLING NETWORK FOR IT - INTEGRATED OFFICE WITH INTRANET CONNECTIONS AND THE ASSOCIATED COMMUNICATION NETWORKS.

15 .R.O PLANT FOR PROVIDING DRINKING WATER. WATER COOLERS AS SHOWN IN THE LAYOUT & TWO NUMBERS REFRIGERATORS OF 600 LITRES CAPACITY. (OF MAKE SAMSUNG / LG / PANASONIC / GODREJ OR EQUIVALENT)

16. AUDIO- VISUAL EQUIPMENTS LIKE OVERHEAD PROJECTORS, DISPLAY BOARDS & VIDEO CONFERENCING IN THE CONFERENCE ROOM. ONE LED TV 40 INCH MINIMUM OF SONY SAMSUNG MAKE SHALL BE PROVIDED IN HOP OFFICE

17 . 1 NO. BORE WELL WITH SUBMERSIBLE PUMP AND ASSOCIATED PIPES AND FITTINGS FOR FILLING OVERHEAD WATER TANK, 3 NOS. PVC OVERHEAD WATER TANK., AND 3 NOS. SEPTIC TANK SHALL BE PROVIDED.

18. COVERED PARKING SHED IN MULTI WALL POLYCARBONATE SHEET & STEEL STRUCTURE FOR 30 NUMBERS CAR &50 NUMBERS TWO WHEELER SHALL BE PROVIDED.

EXCLUSIONS

1. PANTRY / KITCHEN EQUIPMENTS

2. COMPUTERS, UPS AND TELEPHONE SETS

NOTES:

1. ALL THE FINISHING MATERIALS SAMPLES, COLOUR / SHADE SHALL BE GOT APPROVED FROM ENGINEER-IN-CHARGE BEFORE EXECUTION.

2. WHEREVER MULTIPLE CHOICE FOR MATERIALS MAKE HAS BEEN GIVEN, FINAL DECISION OF SELECTION OF MATERIAL MAKE RESTS WITH THE ENGINEER-IN CHARGE.

3. THIS DRAWING IS A PART OF MAIN PACKAGE AND SPECIFICATIONS DETAILED IN THE MAIN PACKAGE SHALL BE APPLICABLE

4. THE SPACE MARKED FOR SEPTIC TANK , BORE WELL AND PARKING FACILITIES ARE INDICATIVE. FINAL LOCATIONS SHALL BE AS PER SITE CONDITIONS

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M(L/O)	M(WS)	E	C	C&I	APPD.	DATE
A	RELEASED FOR TENDER PURPOSE										01.08.16
					CLEARED BY						

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NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
(3 X 800 MW)

TITLE: EPC PACKAGE
CONSTRUCTION OFFICE
ARCH. DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
		9585-001-POC-002	A

CAD FILE NAME :

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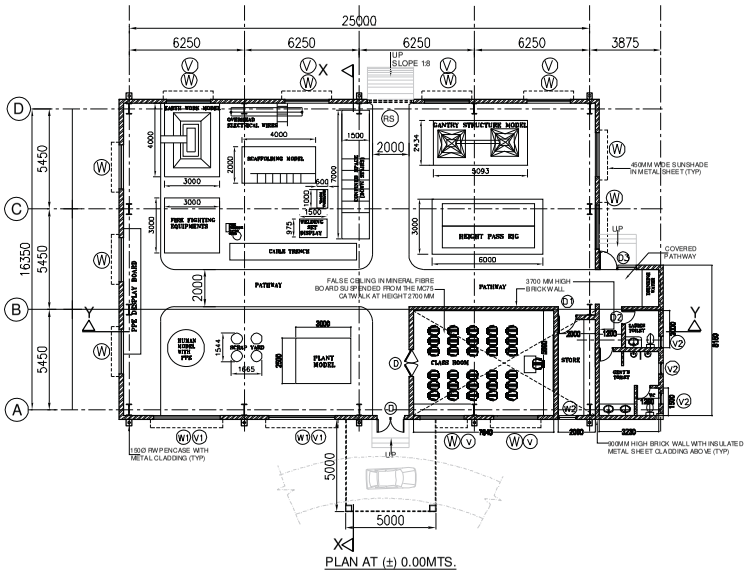
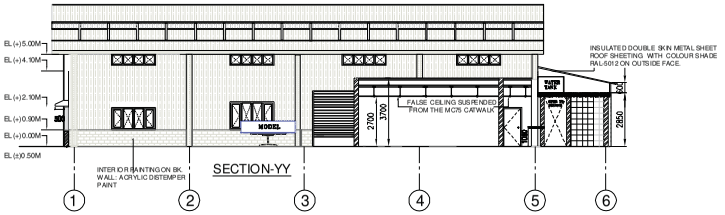
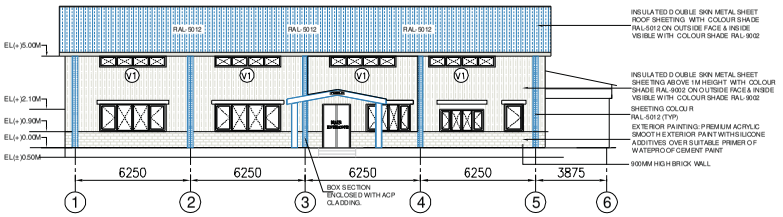
DRG. NO. 9585-001-POC-A-005 REV. NO. A



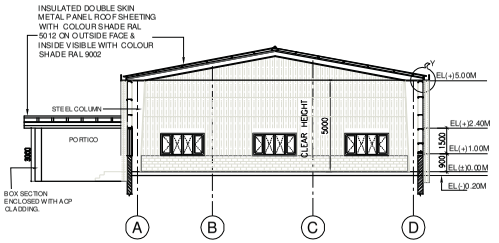
PLAN AT (±) 0.00MTS.



SECTION-YY



FRONT ELEVATION



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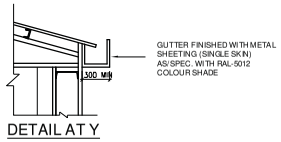

DETAIL AT Y

DOOR/WINDOW SCHEDULE

TYPE	SIZE	CILL LVL.	LINTEL LVL.	DESCRIPTION
D	1500X2400	0.00	2400	AL. GLAZED DOOR
D1	1000X2100	0.00	2100	STEEL DOOR
D2	750X2100	0.00	2100	WOODEN FLUSH DOOR WITH STEEL FRAME
D3	2000X2400	0.00	2400	AL. GLAZED DOOR
RS	2500X3000	0.00	3000	
W	2400X1500	900	2400	
W1	3600X1500	900	2400	
W2	1000X1500	900	2400	
V	3600X600	AS / ELEVATION		
V1	3600X600			
V2	600 X 600	1800	2400	

SAFETY PARK

THIS BUILDING SHALL BE A SINGLE STOREYED BUILDING WITH FLOOR AREA AS / DRG THE PLAN LAYOUT/ BUILDING PROFILE SHALL BE AS SHOWN OF PRE-ENGINEERED BUILDING TYPE WITH STEEL FRAME CONSTRUCTION AND INSULATED SANDWICH CLADDING FOR WALLS AND SANDWICHED METAL SHEET ROOFING. THE DESIGN OF THE BUILDING SHALL BE SUCH SO AS TO HAVE FASTER CONSTRUCTION OF BUILDING AND SO AS TO PROVIDE A READY TO USE BUILDING, COMPLETE AND FINISHED IN ALL RESPECTS TO THE OWNER AND SO AS TO ENABLE SHIFTING AND RELOCATION OF SUPERSTRUCTURE AT LATER DATE.

SCOPE OF WORK

1. DESIGNING, MANUFACTURING, SUPPLYING, PACKING, LOADING, TRANSPORTATION, UNLOADING, INSTALLING AND COMMISSIONING OF PRE-ENGINEERED BUILDING WITH SANDWICHED METAL SHEET WALL & ROOFING,& RAIN WATER DOWN COMER AS PER LAYOUT INCLUDING R.C.C FOUNDATIONS/PEDESTALS, (INCLUDING ANY FOUNDATION REQUIRED FOR EQUIPMENTS) EMBEDMENT OF FOUNDATION BOLTS USING TEMPLATES, ENCASEMENT OF COLUMN BASES, SUPPLY & ERECTION OF DOOR/WINDOW/VENTILATORS/ROLLING SHUTTERS, MASONRY WORK, PLASTERING, PAINTING (INTERIOR & EXTERIOR) FLOORING, FINISHING, PAVING SLAB, PLINTH PROTECTION ETC.

2. SANDWICHED METAL SHEET FOR WALL CLADDING, ROOFING SHALL CONSIST OF TOP SHEET AS TROUGHED PERMANENTLY COLOUR COATED SHEET & BOTTOM SHEET AS PLAIN PERMANENTLY COLOUR COATED FOR COVERING OF EXPOSED METAL/ CONCRETE / BRICK SURFACES WITH 50MM THICK INSULATION SANDWICHED BETWEEN THE TWO SHEETS, EACH SHEET SHALL BE OF STEEL WITH ZINC COATED TO CLASS 275 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.6MM OF GRADE G250 AS PER AS1397 / GRADE SS255 AS PER ASTM A653M / GRADE S250GD AS PER EN 10326 OR OF STEEL WITH ALUMINIUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.5MM OF GRADE G350 AS PER AS1397 / GRADE SS340 CLASS 4 AS PER ASTM A792M / GRADE S350GD AS PER EN 10326 OR OF STEEL WITH ALUMINIUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.4MM OF GRADE G550 AS PER AS1397 / GRADE SS550 AS PER ASTM A792M / GRADE S550GD AS PER EN 10326

3. DOOR & WINDOWS SHALL BE PROVIDED AS PER THE LAYOUT SHOWN . POWDER COATED AL. FRAMES WITH MINIMUM WALL THICKNESS OF 2 MM FOR DOORs, WINDOWS & VENTILATORS WITH 6 MM THICK TOUGHENED GLASS FOR WINDOWS AND 8 MM THICK TOUGHENED GLASS FOR GLAZED DOORS & PARTITION. MAIN ENTRANCE DOOR SHALL BE ALUMINUM GLAZED. FOR TOILET LAMINATED FLUSH DOOR SHUTTER SHALL BE PROVIDED. STEEL DOOR SHALL BE PROVIDED IN STORE ROOM . ALL THE NECESSARY ACCESSORIES AND HARDWARE SHALL BE PROVIDED. VERTICAL VENETIAN BLINDS IN PREMIUM FABRIC QUALITY SHALL BE PROVIDED FOR WINDOWS OF CLASS ROOM.

4. EXTERNAL FACE OF BRICK WALL SHALL BE FINISHED WITH 20 MM THICK PLASTER (1:5 CEMENT : SAND) AND PREMIUM ACRYLIC SMOOTH EXTERIOR PAINT WITH SILICONE ADDITIVES OVER SUITABLE PRIMER OF WATER PRROF CEMENT PAINT. INTERNAL FACE AND INTERNAL BRICK WALLS SHALL BE FINISHED WITH 12 MM THICK CEMENT SAND PLASTER (1:5) AND ACRYLIC EMULSION PAINT OVER WALL PUTTY OF MINIMUM 2 MM THICKNESS

5. FALSE CEILING IN MINERAL FIBRE BOARDS (600 X 600) SHALL BE PROVIDED IN CLASS ROOM & STORE , WHICH IS SUSPENDED FROM CATWALK CONSISTING OF MS STEEL MEMBER HAVING MAXIMUM GRID SIZE OF 1200MM X 600MM FOR SUPPORTING PANELS OF SPECIFIED SIZE. THE STEEL MEMBER SHALL BE PAINTED WITH SUITABLE PAINTING SYSTEM

6. FLOORING IN SAFETY PARK HALL SHALL BE OF MINIMUM 18 MM THICK (600MMX600MM) JHONSON ENDURA INDUSTRIAL TILES OR EQUIVALENT. FOR CLASS ROOM MATT FINISHED VITRIFIED TILE FLOORING MINIMUM 10 MM THICK(SIZE 600 MM X 600 MM) OF KAJARIA / JHONSON MAKE SHALL BE PROVIDED. TOILET SHALL BE PROVIDED WITH DUST PRESSED CERAMIC TILES FLOORING AND DESIGNER DECORATIVE CERAMIC TILE ON WALL DADO UP TO FALSE CEILING / TRUE CEILING. INTERNAL WALLS SHALL BE FINISHED WITH ACRYLIC EMULSION PAINT OVER 2MM THICK WALL PUTTY

7. ALL THE FURNITURE AS SHOWN IN LAYOUT (CHAIR & DESKS IN CLASS ROOM ETC) OF GODREJ / FEATHERLITE / JASANI OR EQUIVALENT MAKE SHALL BE PROVIDED.

8. TOILET IN WORKING CONDITION COMPLETE IN ALL RESPECTS WITH SENSOR BASED WASH BASIN SET IN GRANITE COUNTERS, DUAL FLUSH WALL HUNG W.C WITH SENSOR BASED TAPS OF JAGUAR OR EQUIVALENT. ALL THE NECESSARY ACCESSORIES OF PREMIUM QUALITY SHALL BE PROVIDED . 2 NOS. PVC OVERHEAD LOFT WATER TANK CAPACITY 500 LITER SHALL BE PROVIDED. ALL THE WALLS OF TOILET SHALL BE IN BRICK MASONRY. RUST PROOF AND LEAK PROOF PLASTIC UNDERGROUND SEPTIC TANK OF ADEQUATE CAPACITY AND OF MAKE SINTEX SEPTIC TANK OR EQUIVALENT SHALL BE PROVIDED.

9. INTELLIGENT AND ENERGY EFFICIENT LED LIGHTING WITH MINIMUM LUX LEVEL AS MENTIONED BELOW WITH RECESSED OPTIC LUMINARES / LED DOWN LIGHTERS/ MEDIUM BAY/ PENDANT LIGHT/ ASCENT LIGHT OF PHILIPS/ WIPRO/ CROMPTON GREAVES/ HAVELL OR EQUIVALENT, COMPLETE IN ALL RESPECTS WITH ASSOCIATED CABLING, FIXTURES LIKE FANS , SWITCHES, MCB, ENERGY MANAGEMENT SYSTEM LIKE DIMMERS / SENSORS ETC.
   a) CLASS ROOM.-300 LUX , DECORATIVE MIRROR OPTIC TYPE LED LUMINARIES , LED DOWN LIGHTER
   b) PORTICO:-50 LUX , INDUSTRIAL TYPE LED LUMINARIES .
   c) CORRIDOR / PASSSAGE: 50 LUX , LED LUMINARIES.
   d) BUILDING PERIPHERY LIGHTING :-50 LUX , LED LUMINARIES / LED STREET LIGHT FIXTURES.
   e) OTHER AREAS NOT COVERED ABOVE :- LIGHTING PRINCIPLES SHALL BE BASED AS MENTIONED ABOVE
   f) OTHER SPACE AREA (NONAC AREA-200 LUX-MEDIUM BAY LED LUMINARIES)
   g) STORE- 150 LUX , LED LUMINARIES.
   h) CEILING FANS & BRACKET FAN:- TENTATIVELY ONE NUMBER OF CEILING FAN SHALL BE PROVIDED FOR 10 SQ.M AREA AT SUITABLE MOUNTING HEIGHT. FAN SHALL BE 1200MM SWEEP,CLASS -E OR BETTER INSULATED COPPER WOUND SINGLE PHASE MOTOR ALONG WITH DOWN RODS ETC.& NOS OF 400MM BRACKET CEILING FANS SHALL BE PROVIDED AT STRATEGIC LOCATIONS.

10. ADEQUATE NUMBERS OF SUPPLY / EXHAUST FANS SHALL BE PROVIDED FOR VENTILATING THE BUILDING AND TOILET AREA

11. COMPLETE CONCEALED CABLING NETWORK FOR IT - INTEGRATED BUILDING WITH INTRANET CONNECTIONS AND THE ASSOCIATED COMMUNICATION NETWORKS.

12. R.O SHALL BE PROVIDED FOR DRINKING WATER, WATER COOLERS AS SHOWN IN THE LAYOUT (OF MAKE SAMSUNG / LG / KENT/ AQUAGUARD / PANASONIC / GODREJ OR EQUIVALENT)

13. AUDIO- VISUAL EQUIPMENTS LIKE OVERHEAD PROJECTORS, DISPLAY BOARDS IN THE CLASS ROOM OF SONY/ SAMSUNG MAKE SHALL BE PROVIDED IN CLASS ROOM

EXCLUSIONS

1. SAFETY EQUIPMENTS AS SHOWN IN THE DRAWING

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. THE SIZE/LEVELS OF THE BUILDINGS SHOWN ARE TENTATIVE AND SHALL BE FINALIZED DURING DETAIL ENGINEERING.
4. WORK TO BE EXECUTED AS PER APPROVED FINAL WORKING DRAWING.
5. ALL THE FINISHING MATERIALS SAMPLES, COLOUR / SHADE SHALL BE GOT APPROVED FROM ENGINEER-IN-CHARGE BEFORE EXECUTION.
6. WHEREVER MULTIPLE CHOICE FOR MATERIALS MAKE HAS BEEN GIVEN, FINAL DECISION OF SELECTION OF MATERIAL MAKE RESTS WITH THE ENGINEER-IN CHARGE.

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	RELEASED FOR TENDER PURPOSE	ARCHANA	RK								30.12.16

CLEARED BY

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

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
STAGE-1 (3 X 800MW)

TITLE: SAFETY PARK
ARCHITECTURAL DETAILS & SPECIFICATIONS

SIZE	SCALE	DRG. NO.	REV. NO.
A1	1:100	9585-001-POC-A-005	A

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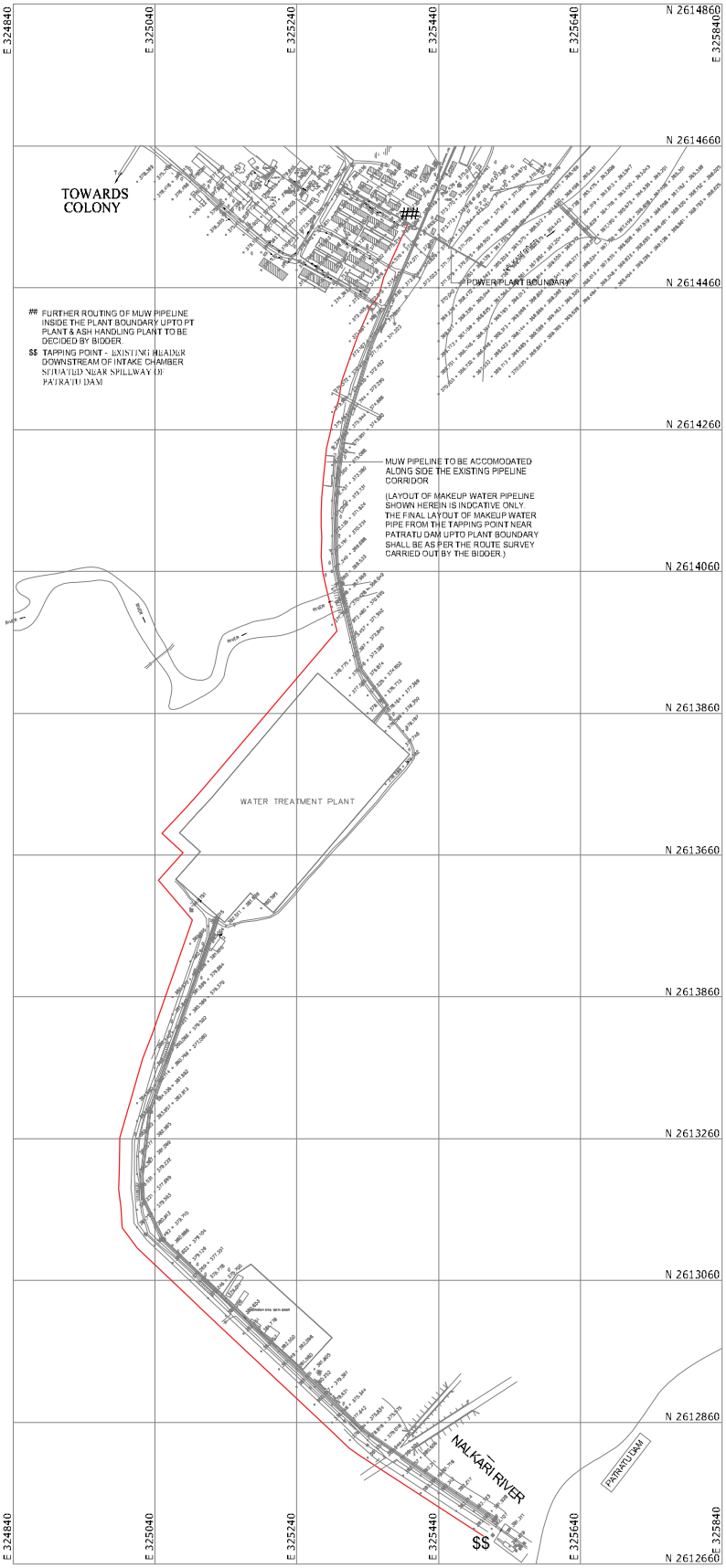

FURTHER ROUTING OF MUW PIPELINE INSIDE THE PLANT BOUNDARY UPTO PT PLANT & ASH HANDLING PLANT TO BE DECIDED BY BIDDER.

$$ TAPPING POINT - EXISTING HEADER DOWNSTREAM OF INTAKE CHAMBER SITUATED NEAR SPILLWAY OF PATRATU DAM

N (MAGNETIC NORTH)
W E
S

WATER PIPE LINE MAP

SCALE:- 1 : 3000

0 30 60 90 120

DETAIL TOPOGRAPHIC SUR EY PLAN FOR
PATRATU SUPER THERMAL
POWER PRO ECT(800MW).
AT PATRATU
DIST. RAMGARH
STATE:- HARKHAND

LEGENDS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	PROPOSED PLANT BOUNDARY		TEMPORARY BENCH MARK
	EXISTING PLANT BOUNDARY		TELEPHONE TOWER
	SURVEY AREA BOUNDARY		HIGH TENSION TOWER
	ASPHALT ROAD EDGE		ELECTRIC DP.
	WBM ROAD EDGE		ELECTRIC POLE WITH LINE (LT)
	CART TRACK EDGE /EARTHEN ROAD		STREET LIGHT
	CEMENT ROAD EDGE		TELEPHONE POLE
	MEDIAN (DIVIDER)		TELEPHONE_DP
	NALLA		TEMPLE,CURCH
	POND		BORE HOLE
	RIVER		BRIDGE
	RAILWAY_LINE		CULVERT
	HIGH TENSION LINE		WATER TAP
	COMPOUND WALL		WATER TANK
	FENCING		WATER PIPELINE AIR VALVE
	DRAIN CENTER		WATER PIPELINE
	DRAIN EDGE(CONST & NATURAL)	W	WELL (LINED)
	QUARRY		STATUS
	POST BOX		FOCUS LIGHT
	HAND PUMP		RAILWAY LINE ELECTRIC POLE
	FLAG POST		VILLAGE BOUNDARY
FS	FOREST BOUNDARY STONE		TREE
	KM STONE		TOWER
	FIRE VALVE		COAL YARD

REV NO	DESCRIPTION	DSGN	CHKD	APPD	DATE
D	ISSUED FOR REVIEW PURPOSE ONLY	DSGN	AAT		
A	ISSUED FOR REVIEW PURPOSE ONLY	DSGN	AAT		

DRAWN | DESIGN | CHKD | APPD | DATE

ISSUED BY

NTPC LIMITED

PROJECT: PATRATU SUPER THERMAL POWER PROJECT

CONTRACT NO: EPC PACKAGE

DRG TITLE: TYPICAL LAYOUT OF MAKE-UP WATER PIPELINE

SIZE: A0 | SCALE: NTS | DRG NO: 9585-001-POC-A-006 | REV NO: B

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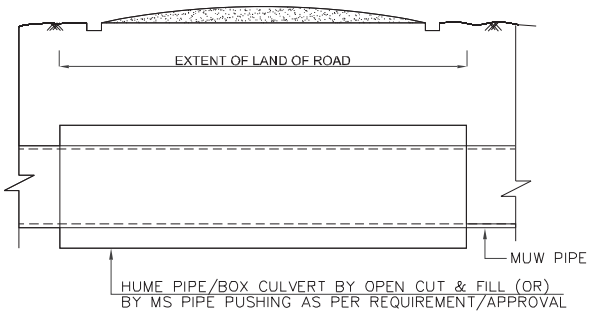
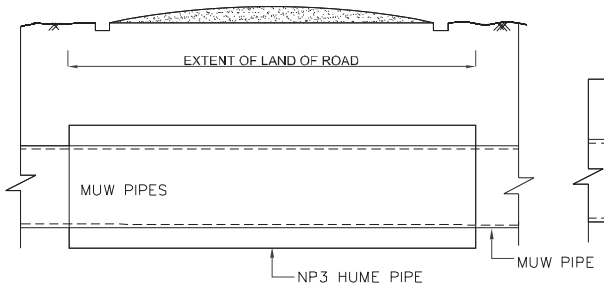
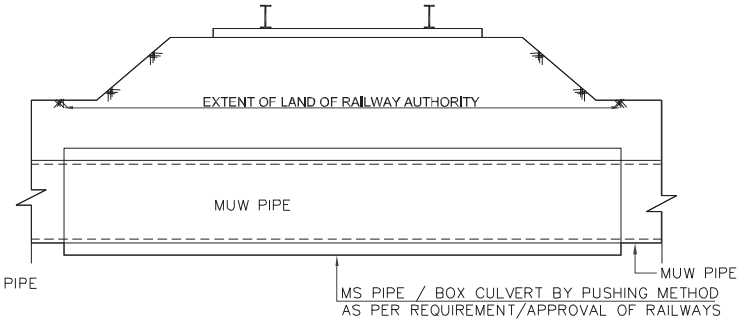


TYPICAL DETAILS AT NH/SH/PUCCA ROAD CROSSING

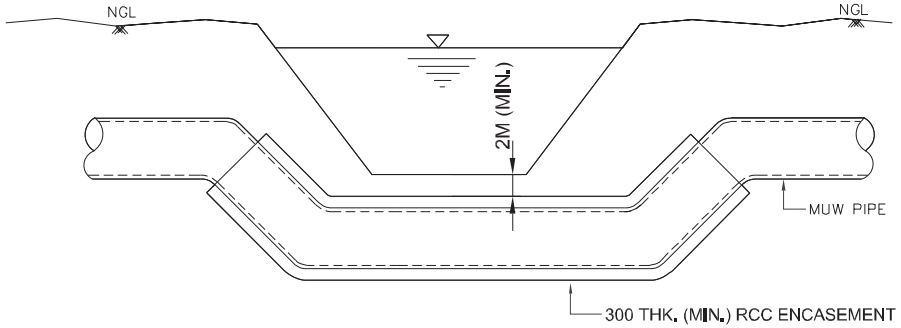


TYPICAL DETAILS AT KUCCHA VILLAGE ROAD CROSSING

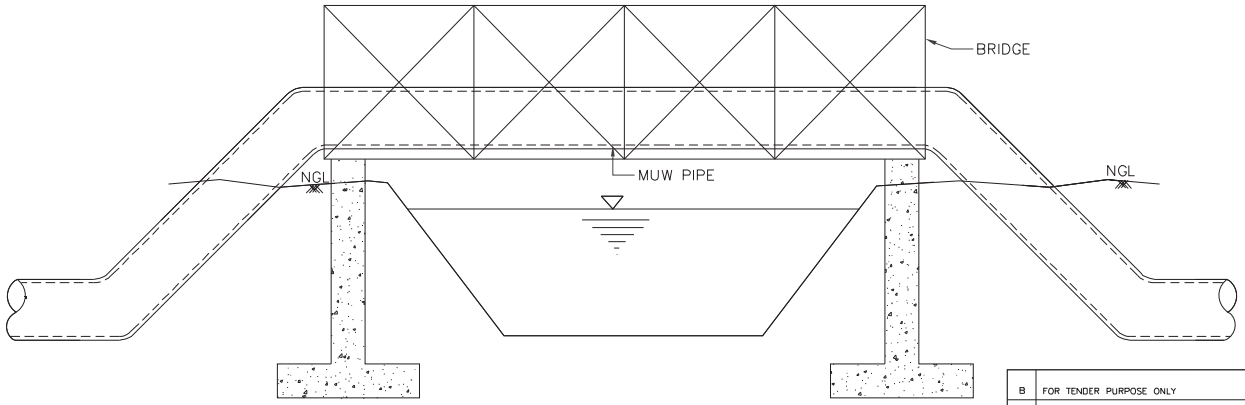


TYPICAL DETAILS AT RAIL CROSSING

(THE CONTRACTOR SHALL APPOINT RAILWAY APPROVED CONSULTANT FOR DESIGNING, OBTAINING APPROVAL FROM RAILWAYS AND EXECUTION OF CULVERT)



TYPICAL DETAILS OF BURRIED PIPE CROSSING AT CANAL / NALA / NON-PERENNIAL WATERWAYS



TYPICAL DET. OF OVER GROUND PIPE CROSSING AT PERENNIAL RIVER / WATERWAYS & MAJOR IRRIGATION CANALS

(MIN. 1.0M WIDE PATHWAY SHALL BE PROVIDED ON THE BRIDGE FOR PIPE MAINTENANCE)

NOTES:

1. THE DETAILS SHOWN ARE INDICATIVE AND MAY CHANGE DURING DETAIL ENGINEERING

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
B	FOR TENDER PURPOSE ONLY	DEEP	AAT								25.04.17
A	FOR TENDER PURPOSE ONLY	DEEP	AAT								12.05.16

CLEARED BY

NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
EXPANSION PHASE-I (3x800 MW)

PACKAGE: EPC PACKAGE

TITLE: TYPICAL DETAILS OF MAKE-UP WATER PIPELINE CROSSINGS

SIZE	SCALE	DRG. NO.	REV. NO.
A2	NTS	9585-001-POC-A-007	B

CAD FILE NAME :

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Annexure-1

7.00.0 FOUNDATION SYSTEM AND GEOTECHNICAL DATA

7.01.0 Soil Data

Owner has carried out preliminary geotechnical investigation at the project site. Available borelogs along with laboratory test results, are enclosed at Annexure-C for Bidder's reference. The preliminary geotechnical investigation report for these areas will be made available for the Bidder's study at the Owner's office, if required.

Onus of correct assessment/ interpretation and understanding of the existing subsoil condition / data is on the Bidder. Bidder may refer topographical survey drawing for variation in existing ground level.

7.01.01 Contractor shall carryout detailed soil investigation for the facilities under this package. The scheme for geotechnical investigation shall be as given at **Clause 7.08.00** and shall be approved by Owner before execution. Geotechnical investigation work shall be got executed by the contractor through the agencies as mentioned in Clause No. 7.07.00. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.01.02 The Bidder should note that nothing extra whatsoever on account of variation between soil/rock data collected by Owner and that found by the contractor during detailed geotechnical investigation by him or during execution of works, shall be payable.

7.01.03 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 **Open Foundations**

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin

stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

e) Contractor shall carry out detailed geotechnical investigation, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	8	10
2.0m below NGL	-	12	15
3.0m below NGL	15	18	20
In case of founding stratum is rock			
0.5m embedment into very dense sand with SPT 'N' Value more than 60 and upto 100	30	35	35
1.0m embedment into disintegrated rock, into very dense sand with SPT 'N' Value more than 100	40.0	40.0	40.0
2.0m embedment into disintegrated rock	50.0	50.0	50.0

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

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

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

7.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250

The piles shall be socketed 5m (minimum) into rock.

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 4 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.02.04 **Foundations in switchyard Area:**

As per General layout plan & topographical survey, major portion of switchyard involves filling varying upto maximum 12m depth to achieve the specified finished formation level. A small portion of the switchyard involves cutting of ground to achieve the specified formation level. Considering the filling involved, contractors may adopt either of following proposed foundation system.

i) Open Foundations for buildings, towers & equipments to be designed resting below NGL as per the criteria as mentioned in Table-1.

or

ii) Pile foundations for buildings, towers & equipments: Piles to be provided as per criteria specified above.

7.03.00 **Special Requirements**

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 **Excavation, Filling and Dewatering**

7.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

7.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.03 **Backfilling in Power House & Boiler Area**

Backfilling around foundations, trenches, sumps, pits, plinths, etc. shall be carried out with sand in layers not exceeding 300 mm compacted thickness and each layer shall be compacted to minimum 80% of relative density.

Backfilling in other area

Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils.
Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.

7.04.04 Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

7.04.05 CBR (California bearing ratio) tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

7.04.06 The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

7.05.00 EXCAVATION IN ROCK

Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02 a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any

operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.
For deep excavation in CHP area, sheet piling / contiguous pile / secant pile / diaphragm walls may be required depending upon the proximity to the existing facilities. The excavation design & scheme shall be developed by a specialized agency.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT), Electrical Resistivity Test (ERT), Cross Hole Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No. **7.08.00.** Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Clause No. 7.08.00. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, recommendation along with slope stability calculation for deep excavation, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

Special requirements for river side/submergence facilities

Contractor may provide suitable foundations as per IRC. The design of river/water body side foundations shall account for local scour around foundations, which shall be assessed by Contractor. Scour calculation shall be as per IRC.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. Cengrs Geotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 Geotechnical Investigation Scheme

a) Boreholes (Minimum)

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main power house, Turbo-Generator (TG)	35 to 45 m along the rows of main power house columns. Minimum 2 boreholes under each TG	Depth of boreholes shall be 25m to 30m.	**Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.**
2	Main Plant structures (Boiler, ESP, Chimney, Mills, Fans etc)	Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 4 boreholes under Chimney, Minimum 2 boreholes under each ESP Control Room, TPs, Fans and Duct Support.	Depth of boreholes shall be 25m to 30m.	
3	Service Building	Minimum 2 no of boreholes	20 to 25 m	
4	CPU Building	Minimum 2 no of boreholes	15 to 20m	
5	Flue Gas Ducting and Absorber Area (FGD)	Minimum 15 boreholes	20 to 25m	
6	Ash Handling Structures	Minimum 8 boreholes	20 to 25 m	
7	Corridors for Ash Conveyors& Make-up water pipeline	1 borehole @ 500 m c/c along the identified corridor and one ERT shall be conducted near each borehole in Ash conveyors.	8-10 m	
8	Crossings along the Ash Conveyor, Makeup water pipeline corridor like road, river, nallah/ canal, Approach bridge	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10.0m	20 to 30m	

9	Air cooled condenser (ACC)	Minimum 10 no of boreholes	25 to 30 m	
10	Switchyard	Minimum 10 No of Boreholes and 8 No of ERT	10 to 15 m	
11	Coal Handling Plant	Minimum 1 borehole under each TP and 1 under each crusher and 1 borehole under each structure. Minimum 10 no of under each stockpile area, 1 in each WT	20 to 30 m	
12	Transformer yard	Minimum 8 boreholes and 8 No of ERT	10 to 15 m	
13	Water and effluent treatment and disposal plant	Minimum 6 no of borehole	10 to 20 m	
14	Pump houses, Control room building, swgr room etc.	4 Nos. boreholes, 3 Nos. ERT and 1 no PLT		
15	Fuel oil unloading and storage system	Minimum 2 Nos.	10 to 20 m	
16	Township	Minimum 8 Nos.	20 to 25 m	
17	Ash Mound Area	Minimum 15 Nos.	10 to 20 m	
18	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
b) Other Field Tests (Minimum)				

1	Plate Load Test (PLT)	2 no in Power House, 3 Nos. in boiler area, 1 No. in CPU, 1 no each in each ESP and 3 Nos. in Ash Handling Structure area in Plant Area, 6 No in Balance of Plant area	Test Depth from 2 to 4 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, 1 no in each Mill, 1 no in ID fan, 1 no in each FGD	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 35 Nos.	Depth - 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 35 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 10.0m in other than Wagon Tippler area. In Wagon Tippler area test shall be conducted at depths of 1.0m, 4.0m,7.0m, 10.0m, 13.0m,16.0m and 20.0m	
5	DCPT	About 10-20% of boreholes up to refusal depth		
6	ERT	6 Nos. in TG/Power House area, 6 nos. in Air cooled condenser, 1 No. in CPU Building, 2 Nos. each in Boiler, Chimney, ESP Control Room, 4 Nos. in Ash Handling Structures area in Plant area, 2 Nos in each FGD. 1No near each Pump		

		House other than mentioned above		
7	CROSS-HOLE TEST	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 15.0 m	
8	PMT	80 no of tests in power house area, SG area & Balance of Plant area	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, Cross-Hole Test, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried

Annexure-2

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\overline{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\overline{V}_B / V_B$. However, no reduction is permitted if $\overline{V}_B$ is less than V_B.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

APPENDIX – I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration (MCE)	: 0.41 g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	
a)	for ordinary moment resisting steel frames designed and detailed as per IS:800	: 0.103
b)	for braced steel frames designed and detailed as per IS:800	: 0.077
c)	For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.062
d)	for RCC chimney	: 0.205
e)	for liquid retaining tanks	: 0.123
f)	for steel chimney	: 0.154
g)	for design of structures not covered under 2 (a) to 2 (f) above and under 3 below	: 0.103
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.205

Notes:
1. g = Acceleration due to gravity
2. For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

APPENDIX – I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.000	1.000
0.04	1.555	1.405	1.293
0.05	2.190	1.828	1.578
0.06	2.898	2.267	1.857
0.07	3.670	2.720	2.131
0.075	3.670	3.175	2.267
0.08	3.670	3.175	2.500
0.083	3.670	3.175	2.500
0.085	3.670	3.175	2.500
0.09	3.670	3.175	2.500
0.1	3.670	3.175	2.500
0.105	3.670	3.175	2.500
0.11	3.670	3.175	2.500
0.115	3.670	3.175	2.500
0.12	3.670	3.175	2.500
0.125	3.670	3.175	2.500
0.13	3.670	3.175	2.500
0.135	3.670	3.175	2.500
0.14	3.670	3.175	2.500
0.145	3.670	3.175	2.500
0.15	3.670	3.175	2.500
0.2	3.670	3.175	2.500
0.22	3.670	3.175	2.500
0.23	3.670	3.175	2.500
0.24	3.670	3.175	2.500
0.3	3.670	3.175	2.500
0.35	3.670	3.175	2.500
0.4	3.670	3.175	2.500
0.45	3.111	2.822	2.222
0.5	2.800	2.540	2.000
0.55	2.545	2.309	1.818
0.6	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.7	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.8	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1	1.400	1.270	1.000

APPENDIX – I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.05	1.333	1.210	0.952
1.1	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.2	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.3	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.4	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.5	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.6	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.7	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.8	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.9	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.1	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.2	0.636	0.577	0.455
2.25	0.622	0.564	0.444
2.3	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.4	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.5	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.6	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.7	0.519	0.470	0.370
2.8	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.9	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.1	0.452	0.410	0.323
3.15	0.444	0.403	0.317

APPENDIX – I

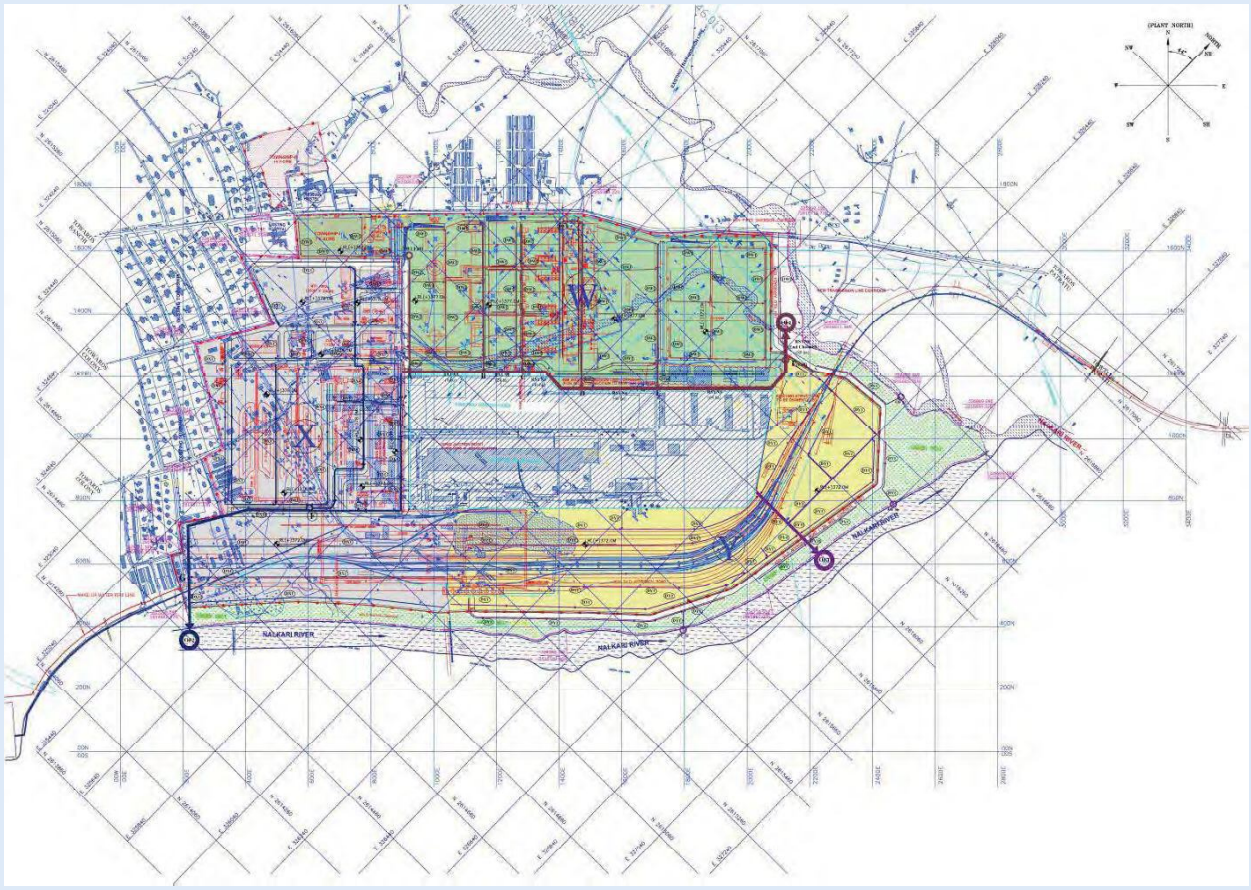
HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
3.2	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.3	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.4	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.5	0.400	0.363	0.286

Annexure-3

Area Drainage Study for Plant and Ash Dyke for Patratu STPP

Sponsor: NTPC Limited, Plot No.A-8A, Sector-24, Post Box No.13, Noida, U.P.



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IITR Project No. WRC/6003/16-17

Area Drainage Study for Plant and Ash Dyke for Patratu STPP

Final Report

May, 2017

Submitted to

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EXECUTIVE SUMMARY

INTRODUCTION

Patratu Thermal Power Station (PTPS) was implemented with Russian collaboration in 1962. It is located near villages Hesla, Jaynagar, koto, Katia and Balkudra just outside the coal belt of South Karanpura in Ramgarh District of Jharkhand State, India. The plant initially had a power generation capacity of 840 MW which was derated to 770 MW. PTPS has six Russian units (Unit #1 to #6) which are 36 to 42 years old and four BHEL (India) manufactured units. Central Electricity Authority (CEA) of Government of India has recommended for immediate phasing out of Unit1, Unit 2, Unit 3, Unit 5 & Unit 8. CEA has also recommended for phasing out of Unit 4 & Unit 6 by 2017 and then phasing out of Unit 9 and Unit 10 in near future.

A Memorandum of Agreement (MOA) was entered on 03.05.2015 amongst Govt. of Jharkhand (GOJH), and NTPC Limited to form a Joint Venture (JV). The MoA was signed for transfer of Patratu Thermal Power Station (PTPS) to the proposed JV Company for performance improvement of existing capacity & for 4000 MW Capacity expansion of PTPS. The JV agreement was signed on 29.07.2015 and JV Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) incorporated on 15.10.2015 with Ministry of Corporate affairs, Govt. of India. The 4000 MW capacity expansion is to be implemented in two phases; Phase-I: 3x800 MW and Phase-II: 2x800 MW. The present proposal is for implementation of Patratu Super Thermal Power Station Phase-I (3X800 MW).

NTPCL vide its letter No. 01/CS-0000-742A-9-PRA dated 02.08.2016 asked IIT Roorkee to submit offer for "Area Drainage Study for Plant and Ash Dyke for Patratu STPP (3x800 MW)". Based on IIT Roorkee offer, NTPCL issued an LOA to IIT Roorkee vide letter no.01/CS-9585-742-9-CY-LOA-6508 dated 06.09.2016 stating therein the scope of area drainage study for Plant and Ash Dyke of Patratu STPP Phase-I. The scope of work is explained in chapter 1.

Field Visit and Review of Available Information

Site visit was conducted during 14.10.2016 to 15.10.2016 Reconnaissance survey of the topography, soils, existing land use, and natural drainage was carried out along with the staff of NTPC Ltd and discussions were held with project staff at site. Documents/Data have been

collected from various sources (list of documents given in chapter 1) and relevant information has been utilized in this study:

STUDY AREA CHARACTERISTICS

Location and Layout Plan of PSTPP Phase-I

The proposed site of PSTPP Phase-I is located near Patratu village in Ramgarh district of Jharkhand state. Proposed site is about 27 km from National Highway NH-75. State Highway SH-2 which is adjacent to plant boundary connects the plant with NH-75 and NH-33.

The layout of the proposed Stage-I (3X800MW) has been developed in the space available between the existing plant boundary wall and public road on North side of the plant (see figure in chapter 6). The total land to be transferred by the Government of Jharkhand/JUUNL to JV Company is 1859 acre. Out of 1859 acre, about 1234 acre of land has been envisaged for Patratu STPP, Phase-I (3X 800 MW) Plant, Ash pond and Railway Siding.

The main power house is along East-West direction. The proposed plant is envisaged with Air Cooled Condenser and space for the same is kept towards East side in between the plant and switchyard. Administration Building is proposed to be located outside the plant boundary near the main approach road. The main power house will be 420.5 M long and 41.0 M wide consisting of TG bay and heater bay.

Two ash dyke areas are available. Approx. 400 acre of land is available in Dyke -I. The land is located about 3 km from the plant boundary. The ash Dyke-II of about 300 acre is presently being used for disposal of ash from the existing units of Patratu Plant. It is also located about 3 km from the plant, but on the diametrically opposite side of Dyke -I.

Natural Drainage

The study area (within 10 km radius from main plant) lies in the upper Damodar valley. Drainage pattern is in west to east direction in northern and central part of study area whereas it is from south to north in southern part of study area. Sources of water for the proposed and future thermal power plants are the existing reservoir at Patratu and runoff in tributary sub catchments in upper Damodar valley. Upper Damodar River (also known as Deonad) is the main river in study area. Nalkari River is a right bank tributary of Upper Damodar River. Average annual rainfall in the catchment is 1270 mm. The Nalkari River attained the maximum flood level of

367.5 m near Patratu power plant site in the year 1958 i.e. prior to construction of the Nalkari dam.A dam has been constructed on Nalkari River near village Patratu during the period 1962-1968 and it is now more than 50 years old.

Natural Drainage in vicinity of Plant Area and Ash Dykes

Nalkari River: The existing Patratu power plant and the proposed plant lie in the adjacent to Nalkari river in downstream of the Nalkari dam.

Tilaiyatar nala : It passes through the ash dyke-II area. The Tilaiyatar nala joins Nalkari river on its left bank.

SY nala: Another nala passes through the proposed site of main plant area. It is named SY nala for the sake of discussion. SY nala joins theTilaiyatar nala coming from Ash dyke–II area.

Purnatoli nala: A nala passes through the ash dyke-I area. Ash Dyke-I area lies on the right bank side of Nalkari river. The Purnatoli nala joins Nalkari river on its right bank

Soil Type, Land Use /Land Cover

CIMFR (2015) have carried out soil analysis of samples from the sapling locations in upstream and downstream of of ash pond; six times in the year 2014 .The analysis shows that soil type is sandy loam.

Land use and land cover map was prepared using remote and GIS techniques. The area is mainly occupied by Dense Forest (28.54 %), Agriculture (23.41 %), Fallow land (19.80 %), Open Forest (13.84 %), Waste land (6.63 %), Settlement (4.06 %) and Waterbody (3.72 %).

Climate

The area lies in the sub-humid region of Chotanagpur Plateau and enjoys semi-extreme type of climate. The day temperature rises around 40 °C during the summers and drops down to around 10 °C during the winter. Three broad seasons can be recognized; the winter season(November to February); the hot season(March to May) and the rainy season(June to October).The average annual rainfall in Ramgarh district is 1251 mm More than 80% of the precipitation is received during the monsoon months.

DIGITAL ELEVATION MODEL STUDY

Digital elevation model (DEM) is the digital representation (digital map) of the ground elevation data in meters. The following data have been used for DEM study:

i) Contour map of the plant area with contour interval of 0.50 m. This map has been prepared using recent grid survey data of the plant area.

ii) Geographic referencing points: These have been extracted from the features common in the toposheet and the map based on recent topographic survey and georeference points provided by M/S NTPC Limited.

iii) Survey of India Toposheet (1: 50000 scale): Toposheet Number 73 E/2 and 73 E/6 of year 1978-79.

iv) Plant layout map showing location and ground formation levels of various components of the Patratu Super Thermal Power Project (STPP)

DEM of the plant area: North part of the plant area has lowest elevation of 357.5 m whereas the South West part has highest elevation of 388.9 m. . The central part of the plant area has an elevation of 380.5 meter. The North West part of the study area has elevation in the range of 366.0 m to 375.0 m. North Eastern part of the study area has an elevation of 376 m to 380 m.

DEM of the ash pond area 2: The north eastern part of the Ash pond area has lowest elevation of 376 m. The North western part of the study area has highest elevation of 388 m.

DEM of the ash pond 1: The variation in elevation is from 356 m to 391 m in the ash pond 1 area. North-eastern part of the Ash pond area has lowest elevation of 356.0 m. The south-eastern part of the ash pond area has highest elevation of 391 m.

DEM of the Green belt area: Southern part of the Green belt area has highest elevation of 374 m. The Northern part of the study area has lowest elevation of 350 m.

DEM of the colony area: North eastern part of the colony area has lowest elevation of 372 m. The South western part of the study area has highest elevation of 395 m.

Generation of Stream Network: The Spatial analyst tools of ARC-GIS software has been used for generation of stream network.Drainage network created from DEM was overlaid with the

topo sheet drainage network. It is seen that major drainage of the study area is matching with the drainage created from DEM. Drainage of the area has not much changed over the time period.

Distribution of Land Area at Different Elevation: The Digital Elevation Model prepared in ARC-GIS has been used to compute the land area between different elevation ranges separately for plant area, ash pond-I, ash pond-II, colony area, and green belt area. This information in tabular and graph form(details in chapter 3)will provide a guideline for fixing FGL and for deciding volume of cut and fill earth work in each of the component area.

DESIGN STORM SCENARIOS

Design storm and flood scenarios are required for (i) planning of drainage in the plant area and vicinity and (ii) for assessing possible submergence in the plant area from internal and external flooding.

Frequency Analysis of 1-Day Annual Maximum Rainfall at Ranchi: Daily rainfall data are available at Ranchi from 1971 to 2011 (41 years). 1-Day annual maximum rainfall series was constructed and EV Type I probability distribution was applied to estimate 1-day and converted 24 hour rainfall of 25 year,50 year and 100 year return period .

Regional Depth Duration Frequency Studies: The study area lies in Lower Ganga Plains Sub Zone defined by Central Water Commission (CWC 1994). India Meteorological Department (IMD) has conducted detailed rainfall study for this Sub Zone (CWC 1994) utilizing the data of 49 self-recording rain gauge stations and 173 ordinary rain gauge stations The Upper Damodar Valley area covered by the subzone provides well distributed SRRG data of 26 stations in 4 districts of Bihar (now Jharkhand).The CWC report provides Isopluvial maps of 25 year,50 year and 100 year return periods .

Recommendation: The 24 hour rainfall of 25 year(177 mm),50 year(201mm) and 100 year return period (232 mm) as per frequency analysis of 41years data at Ranchi and those as per isopluvial map are similar . It is recommended that the 24 hour storm rainfall values obtained from frequency analysis of 41 years rainfall data at Ranchi be used in further analysis as the station is close to the study area and data of recent period (1971 to 2011) and of sufficient length (41 years) have been used in the frequency analysis.

POSSIBILITY OF EXTERNAL FLOODING

Flooding due to flood in Nalkari river: Nalkari (a southern tributary of Upper Damodar river) is the major stream in vicinity of the power plant. The Nalkari river attained the maximum flood level of 367.5 m near Patratu power plant site in the year 1958 prior to construction of the Nalkari dam. The dam was constructed during the period 1962-1968. Flow in the Nalkari river in downstream of dam is controlled by operation schedule of the Nalkari reservoir. The Patratu reservoir has helped in significant reduction in flood water level in the downstream of the dam. Thus flood levels in vicinity of power plant are expected to be much lower than the maximum flood level which occurred in the year 1958 prior to construction of the Nalkari dam. The proposed FGL in plant area and town ship vary from372.0 m (in space for switch yard) to 382.0 m in township area which are much higher than the maximum flood level of 367.5 m prior to construction of the Nalkari dam.

The natural ground level in ash pond -II varies from 376.26 to 388.26. These elevations are much higher than the flood level in the natural streams in vicinity. Figure 5.3(chapter 5) shows the flood level of 367.5 m at different locations in area around plant site. Flooding can occur in vicinity of plant area only in case of dam breach for which a separate dam break study may be carried out.

Due to siltation in reservoir, effectiveness of reservoir (over a long period) in flood moderation could decrease. The dam is now 50 year old. In an earlier study by IIT Roorkee, capacity survey of Nalkari reservoir was carried out using remote sensing data. The capacity survey was carried out for the period 2006 to 2012 for the zone of reservoir level fluctuation between 387.096 m to 406.152 m. The original live storage capacity of 110.73 MCM reduced to 89.96 MCM (i.e. by 11.76 %) over the period of 44 years from 1968 (the year of construction) till the year 2012.

Flooding in Plant Area Due to SY Nala

This nala passes through the proposed site of main plant area. It joins the Tilaiyatar nala coming from Ash dyke–II area. The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area.In the present study, 100 year flood in the SY nala has been estimated to assess possibility of flooding under existing conditions in the vicinity of the SY nala.

Flood in SY nala has been estimated using i) Rational Formula and ii) Regional Flood Frequency Model of CWC (1994). It is found that the estimated floods are of similar magnitude. It is recommended to use flood estimate using Rational formula as catchment size is very small for which rational formula is more appropriate as recommended by Central Water Commission (CWC 1994) and by *Research, Design &Standards Organization (RDSO) of Indian Railway, Government of India* (Report RBF 16).

In order to assess the flooding, bankful discharge capacity of SY nala has been estimated using slope area method. For estimation of cross section parameters, approximate ground levels on the left and right banks have been worked out with the help of recent contour map of the plant area. The bankful discharge of capacity of SY nala is significantly higher than estimated 100 year flood in this nala . Hence it is safe to conclude that flooding doesn't occur under pre project condition. During the field survey of the plant area villagers stated that flooding has never occurred in the area.

External Flooding in Post Project Condition

Existing land use, land cover and topography in the project area will get modified during post project condition. However, the net effect of changes in land use, land cover and topography in post project condition shall be negligible. The flood generated by storm rainfall is expected to be similar as for pre project condition as explained in chapter 5.

Realignment of SY Nala: The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area. Layout and design channel capacity of the realigned Gangai nala are discussed in chapter 6.

Bank Protection For Existing Drains: Carrying capacity of a) Nalkari river (in the reach along the project boundary), b)entire length of realigned SY nala, c) Tilaiyatar nala in downstream of ash dyke-II and d) Purnatoli nala in downstream of ash dyke-I shall have to be maintained so that flood discharge is carried safely . No encroachment should be allowed in the flood plain of these drains.

INTERNAL DRAINAGE AND REALIGNMENT OF SY NALA

The plant components have been located on different ground formation levels by NTPC to economize the cost of earth work. The proposed formation levels are 372 m, 377 m, 378 m and

382 m. The DEM (chapter 3) can be used to identify areas requiring cutting and filling and to estimate the volume of earthworks required to level the undulating topography of the study area. Due consideration has been given to the existing slope of project area towards south and towards east in deciding the layout of internal drainage.

Three outfalls (OF1,OF2,OF3,) are envisaged for drainage of township, plant area and rail track area .Accordingly, the area is partitioned into three zones such that storm runoff from each of the zone is carried separately to the Purnatoli nala (through realigned SY nala) and to Nalkari river . Figure 6.2 and Table 6.2 show the partition of project area into W, X, Y, zones and drainage plan showing plant area drains.

W Zone: It includes switch yard, main plant area and any vacant land between Patratu – Ranchi road and the realigned SY nala,.The storm runoff shall be carried by realigned SY nala which has Outlet OF1 on end channel of original SY nala just upstream of confluence with Tilaiyatar nala.

X Zone: It includes Township-I area, Administration building area, WTP area, workshop, ZLD for FGD, temp gypsum storage, crushed coal stock pile area, wind barrier for coal stock yard, part of rail track and other area occupied by misc facilities. Internal drainage for township area will depend on layout plan of the township. Location of Outlet OF2 for zone X will be on Nalkari river. Depending on whether combined or separate sewage and sewerage system are planned, the storm runoff from coal yard area can be separated and storm runoff is carried to another outfall adjacent to OF2.

Y Zone: It mainly includes Railway track area and open land between a)existing main plant upto Nalkari river bank and b)open land on east side between existing plant and boundary of proposed plant . Outfall (OF3) for this zone is located on Nalkari river. W zone also includes 12 m wide ash silo approach road which is located along the green belt. Storm water runoff from this road and adjoining area can be separately drained into Nalkari river at outfalls OF3a, OF3b and OF3c.

As per NTPC norms, internal drains are to be designed to safely carry 25 year flood so as to economize the cost of construction, maintenance and cost of land which shall be occupied by the drains. The 25 year flood estimate in SY nala has been explained in chapter 5. The 25 year flood estimate in SY nala is 11.7 cumec and discharge per unit area is 0.152 cumec/ha.

Carrying Capacity and Size of Channel Segments

It is not necessary that a long drain should have same discharge carrying capacity throughout its length to carry the entire discharge generated from its catchment. In order to economize the cost and land area occupied by drains, a suitable number of channel segments may be considered. An unit length of approximately 200 m has been considered for a channel segment and its own contributing catchment is taken to be about 4 hectare (200mx200m).Discharge contributed by catchment of a channel segment is added to the capacity of its upstream channel segment(s) to estimate carrying capacity of the particular channel segment. Layout and carrying capacity of drains in zone W, X, and Y have been worked out. Size of different channel segments in zone W, X, and Y are stated in table 6.4, table 6.5 and table 6.6 respectively. Figure 6.3, Figure 6.4 and Figure 6.5show layout of channel segments in zone W,X,Y respectively. **Carrying capacity of different channel segments of the Realigned SY nala (RSYN) are stated in table 6.4. It is master drainage channel of W zone .It is designed to carry storm runoff from W zone and from existing plant area.**

6.3.2 Channel Sections for Internal Drainage and Realigned SY Nala

Internal drainage channels as well as the realigned SY nala (RSYN) are designed as rectangular open channel to take discharge from assigned drainage areas. Manning's roughness coefficient is taken for concrete channel (0.016). Width of drains shall not be less than 0.75 m considering cleaning by mechanical means.

Bed Slope: Internal drainage channels in W,X,Y zones will have bed slope of 1:1000 i.e.1m/km or 0.001.However, the last two channels(end channel and preceding channel) in each zone will be laid at 1;500 slope(s=0.002) as sufficient natural gradient is available. This will reduce size and hence capital cost of drain.

The realigned SY nala (RSYN) is considered as master drain of W zone. It will carry runoff from W zone and also from existing plant area.It is proposed to lay the realigned SY nala on a slope of 1:500(i.e.1m/500 m or 0.002) having rectangular concrete section. Cross section of RSYN is increased in steps to accommodate flow contribution from various parts of W zone and existing plant.

Vertical Falls on Channels

Plant components in W zone are at different FGL (382 m, 377 m, and 372 m). Similarly plant components in X zone are at different FGL (378 m and 372 m). Therefore, vertical falls are necessary to negotiate difference in bed level of connecting channels. Well type fall (also called cylinder fall) is suitable and economical for large height fall and small discharge. For low height fall and large discharge, crest weir over full width of channel is suitable. Location of vertical falls in W zone and X zone are shown in figure 6.3 and 6.4 respectively. Location and size of vertical falls in W zone and X zone are given in table 6.7 and table 6.8 respectively.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The National Thermal Power Corporation Limited (NTPC) is largest power generating corporation in India. Although the corporation has 17.73% of the total national capacity, it contributes 25.91% of total power generation with focus on high efficiency. Presently, it has total installed capacity of 45,548 MW (including Joint Ventures) and has an ambitious growth plan of becoming a 1, 28,000 MW Corporation by the year 2032. NTPC has adopted a multi-pronged growth strategy which includes capacity addition through green field projects, expansion of existing stations, joint ventures, subsidiaries, and take-over of stations. The company was rechristened as NTPC Limited on October 28, 2005. Furthermore, it was conferred with "MAHARATNA" status by the Government of India on 21.05.2010.

A Memorandum of Agreement (MOA) was entered on 03.05.2015 amongst Govt. of Jharkhand (GOJH), Jharkhand Urja Vikash Nigam Limited (JUVNL), Jharkhand Urja Utpadan Nigam Limited (JUUNL), Jharkhand Bijli Vitaran Nigam Limited (JBVNL) and NTPC Limited to form a Joint Venture (JV) Company of NTPC Limited & JBVNL(with 74:26 equity participation).The MOA was for transfer of existing Patratu Thermal Power Station (PTPS) (located in Tamgarh district of Jharkhand state) to the proposed JV Company for performance improvement of existing capacity & 4000 MW Capacity expansion of PTPS. The JV agreement was signed on 29.07.2015 and JV Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) incorporated on 15.10.2015 with Ministry of Corporate affairs, Govt. of India.

The existing Patratu Thermal Power Station (PTPS) is located near village Patratu in Ramgarh District of Jharkhand State. The PTPS was implemented with Russian collaboration in 1962. The plant initially had a power generation capacity of 840MW (unit #1 to #4: 50 MW +unit #5 & #6: 100 MW + unit #7 &#8: 110 MW +unit #9 &#10: 110 MW) derated to 770 MW (unit #1 to #4: 40 MW +unit #5 & #6: 90 MW + unit #7 &Unit #8: 105 MW + unit #9 &Unit #10: 110 MW).PTPS has six Russian units (Unit #1 to #6) of 36 to 42 years old and four BHEL manufactured units. CEA has recommended for immediate phasing out of Unit #1, 2, 3, 5 & 8. CEA has also recommended for phasing out of Unit #4 & 6 by 2017 and phasing out of Unit #9 and 10 by 14th Plan.

The capacity expansion of 4000 MW is to be implemented in two phases; Phase I: 3x800 MW and Phase II: 2x800 MW. The present proposal is for implementation of Patratu Super Thermal Power Station Phase-I (3X800 MW) capacity.

NTPCL vide its letter No. 01/CS-0000-742A-9-PRA dated 02.08.2016 requested IIT Roorkee to submit offer for "Area Drainage Study for Plant and Ash Dyke for Patratu STPP (3x800 MW)". Based on IIT Roorkee offer no. WR/AP/905 dated 05.08.2016, NTPCL issued an LOA to IIT Roorkee vide letter no.01/CS-9585-742-9-CY-LOA-6508 dated 06.09.2016 stating therein the scope of work and the terms and conditions acceptable to IIT Roorkee. Dean of Sponsored Research and Industrial Consultancy (SRIC) of IIT Roorkee approved this consultancy work as per norms of IIT Roorkee.

1.2 SCOPE OF WORK

The scope of work assigned to IIT Roorkee is as follows:

A. Survey Work and Area Drainage

1. Study of existing natural drainage pattern/system, available information in the form of reports, literature, satellite imageries, etc. having a bearing on the storm water drainage system of proposed plant and ash dyke areas of the project and its adjoining areas. The study shall include review of topographical features of the proposed site and its surrounding areas.
2. Review and analysis of rainfall information to arrive at design storm scenarios.
3. Review and analysis of relevant Survey of India Topographical Sheets, topographical survey and satellite imageries.
4. Estimation of flood hydrographs considering historical as well as design rainfall to suggest complete scheme for storm water drainage of site and its adjoining area including diversion of nallas/streams, if any.
5. Estimation and routing of design flood hydrograph through the drainage system of concerned catchments considering appropriate boundary conditions including pre-construction scenario as well as post-construction scenario for suggesting remedial measures for the site
6. Suggesting final disposal point for the storm water from site and size of the disposal drain
7. Site visit for acquaintance of prevailing conditions and collection of available data at site.
8. Visit to NTPC corporate Engineering office for discussions regarding the study.

1.3 FIELD VISIT AND REVIEW OF AVAILABLE INFORMATION

Site visit was conducted during 14.10.2016 to 15.10.2016 Reconnaissance survey of the topography, soils, existing land use, and natural drainage was carried out along with the staff of NTPC Ltd.

Documents/Data given below have been collected and relevant information has been utilized in this study:

1. Daily rainfall data for IMD station at Ranchi
2. IIT Roorkee(2013): Report (March 2013)on Water Availability Study of Patratu Reservoir and Related Thermal Power Plants prepared for PFC Consulting Ltd New Delhi.
3. IIT Roorkee(2010): Report(October,2010) on Identification of Water Source For Power Plant Linked to Mourya Coal Block (Jharkhand) prepared for PFC Consulting Ltd New Delhi
4. CGWB(2013): Ground Water Information Booklet of Ramgarh District, Jharkhand State by Central Ground water Board(Ministry of Water Resources,Govt. of India)(September,2013)
5. Natural drainage within proposed plant area and vicinity based on reconnaissance survey of the area.
6. NTPC Feasibility Report of Patratu Thermal Power Station Expansion-Stage I(DOC. No.:9585-999-NOG-J-001 R '0')
7. MoEF and CC: ToR for Patratu Super Thermal Power Project Phase I(3x800 MW) issued vide letter dated 7.6.2016
8. CIMFR(March,2015):Report on Evaluation of Different Environment Parameters at PTPS(Jan2014-Dec 2014) by Central Institute of Mining and Fuel Research, Dhanbad
9. CWC (2001): Manual on Estimation of Design Flood, Central Water Commission, Government of India,New Delhi .
10. CWC(1994): Flood Estimation Report for Lower Ganga Plains Subzone-1(g), Central Wat6er Commission, Government of India, New Delhi
11. RDSO:Report No RBF-16 'Flood Estimation Methods for Catchments Less Than 25 Km2 in Area' prepared by Research, Design &Standards Organization(RDSO) of Indian Railway, Government of India

CHAPTER 2

THE STUDY AREA CHARACTERISTICS

2.1 PHYSICAL ENVIRONMENTAL SETTING OF THE SITE

The proposed site of PSTPP Phase-I is located near Patratu village in Ramgarh district of Jharkhand state. It is adjacent to the existing Patratu thermal power plant. Environmental setting of the proposed plant site is given in table 2.1.Figure 2.1 is the index map of the proposed plant.

Area vicinity map within 10 km radius is given in Figure 2.2.

Table 2.1: Physical Environmental Setting of Proposed Plant Site

Sl. No.	Particulars	Details
1	Plant location	Near Patratu village in Ramgarh district of Jharkhand state in India
2	Toposheet Nos.	Survey of India Toposheet number 73E/6 on 1:50000 scale.
3	Site Coordinates	Latitude 23°37'30"N and Longitude 85°16'25"E
4	Plant site elevation above MSL	405 m above msl
5	Road Connectivity	Proposed site is about 27 km from National Highway NH-75. State Highway SH-2 which is adjacent to plant boundary connects the plant with NH-75 and NH-33.
6	Nearest railway station	Patratu about 5.5 km
7	Nearest Airport	Birsa Munda Airport Ranchi about 50 km
8	Nearest major water bodies	Nalkari reservoir on Nalkari river
9	Nearest village	Patratu
10	Nearest town/City	Ramgarh about 35 km
11	Reserved (RF) / Protected Forests	None
12	Source of water	Patratu reservoir (Nalkari Dam)

The total land to be transferred by the Government of Jharkhand/JUUNL to JV Company is 1859 acre. Out of 1859 acre, about 1234 acre of land has been envisaged for Patratu STPP, Phase-I (3X 800 MW) Plant, Ash pond and Railway Siding.

2.2 GENERAL LAYOUT PLAN

General Layout Plan (GLP) for the project is given in chapter 6. The layout of the proposed Stage-I (3 × 800MW) has been developed in the space available between the existing plant boundary wall and public road on North side of the plant. Some of the existing structures in the proposed area shall need to be dismantled. The public road may also require diversion in some stretches depending upon the availability of space for the proposed facilities.

The switchyard orientation has been planned towards East side of the main plant block taking into consideration the requirement of power evacuation. The main power house is along East-West direction, with permanent facilities like Workshop, Permanent stores etc., located close to the main plant. The Chimney is towards West of main plant. The ash slurry/ash water pump house is kept towards near chimney. Space provision for FGD has been kept towards West of main plant beyond chimney.

The proposed plant is envisaged with Air Cooled Condenser and space for the same is kept towards East side in between the plant and switchyard. The water treatment plant and the DM water facilities are located close to main plant. The coal handling plant and the coal stockyard are located towards South-West of the main plant considering the railway siding from South side.

Administration Building is proposed to be located outside the plant boundary near the main approach road. The main plant building arrangement for the proposed stage -I of the plant envisages longitudinal disposition of TG set. The main power house will be 420.5 M long and 41.0 M wide consisting of TG bay and heater bay.

2.3 ASH DISPOSAL AREA

Two ash dyke areas are available. At one place approx. 400 acre of land is available (Dyke #1). The land is located about 3km from the plant boundary. The second area (Dyke #2) of about 300acre is presently being used for disposal of ash from the existing units of Patratu Plant. It is also located about 3km from the plant, but on the diametrically opposite side of Dyke #1.

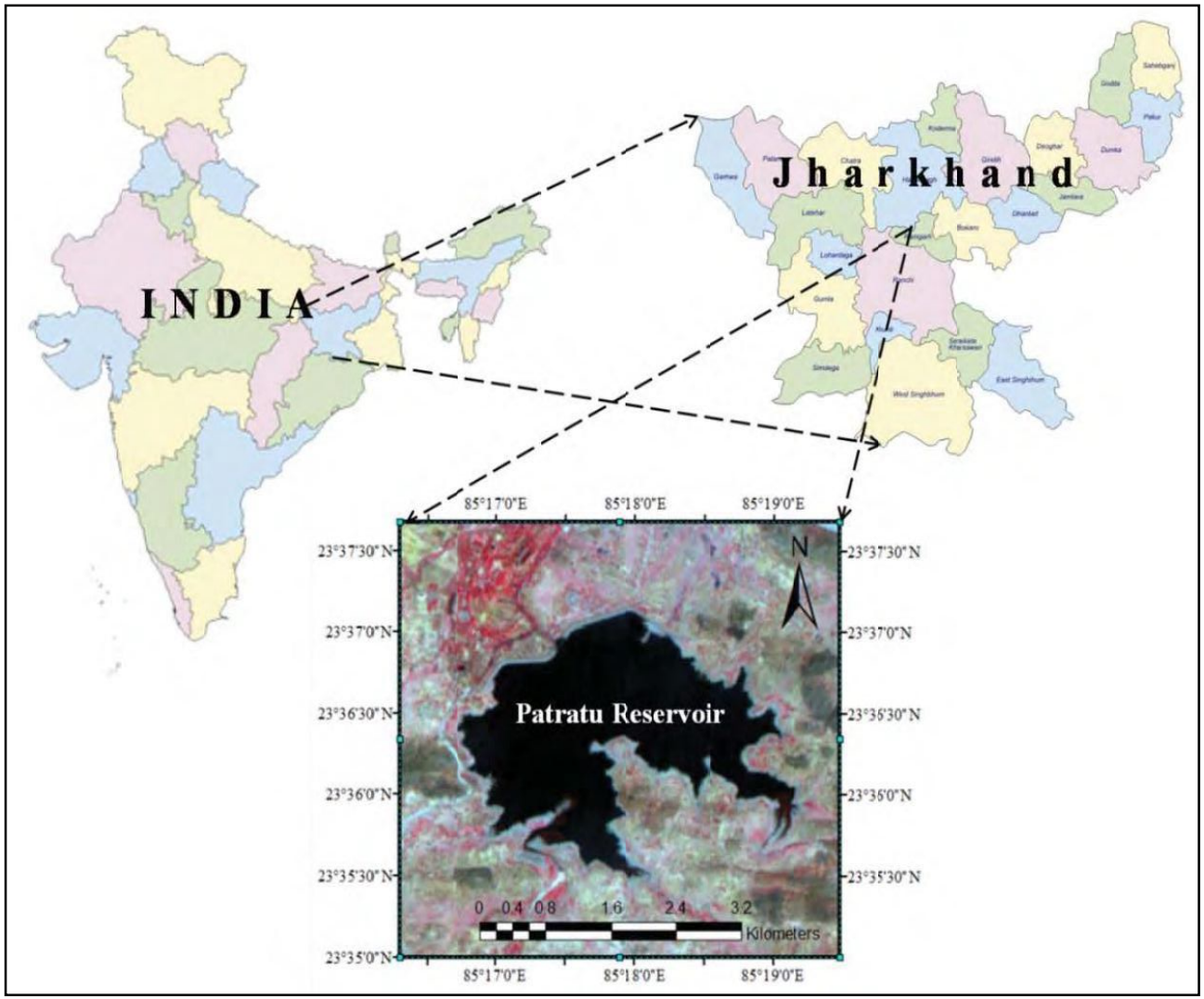

Figure 2.1: Index map of Patratu plant site and reservoir

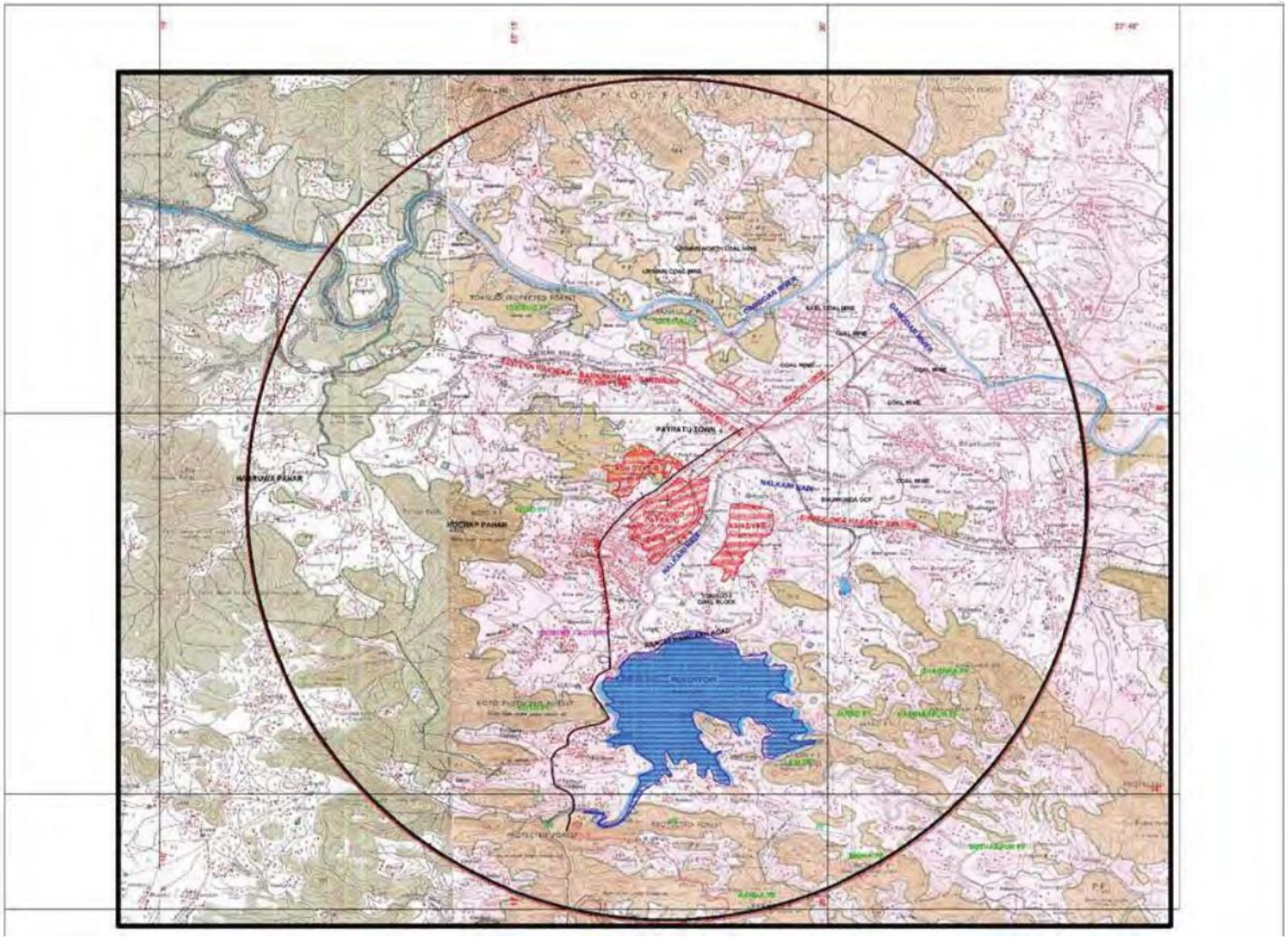

Figure 2.2: Vicinity map of the Study area (10 km radius)

Presently, ash is being disposed in the form of lean slurry. As per MOEF guideline, 600acre of land is required for disposal of ash from Patratu STPP, Phase-I, 2400 MW (3X800MW) i.e. @

0.25 acre/MW. The undulations of ground levels on Dyke #1land may be of the order of 5-10m. A dyke embankment exists and average height of this embankment is about 4-5m.

Fly Ash (FA) from new units of Patratu STPP, Phase-I (3X800MW) is proposed to be disposed off through High Concentration Slurry Disposal (HCSD) system and bottom ash (BA) in the form of lean slurry.Considering the availability of two existing ash dyke areas at two different locations, it is envisaged to utilize Dyke #1 (about 400 acre) area for FA disposal and Dyke #2 (about 300acre) for BA disposal.

For developing 11.51 million cu.m (9.21 million cu.m FA & 2.30 million cu.m BA) of storage capacity, two storage lagoons for Fly Ash disposal by High Concentration Slurry Disposal (HCSD) system at Dyke #1 & two storage lagoons for disposal of bottom ash by wet slurry disposal system at Dyke #2 with one overflow lagoon at each location for storing decanted water from above storage lagoons will be constructed. For developing 9.21million cu.m capacity at Dyke #1, average 6m and 8m high embankments are envisaged and will be constructed on existing ground along the periphery of the HCSD area. Existing Dyke #2 is presently being used for slurry disposal from existing units and is almost exhausted.

For BA disposal from new units, it is envisaged to use existing Dyke #1 by strengthening and 3 future raisings of 3m height each to cater to BA disposal as per norms. However, extent and type of strengthening shall be decided after getting detailed topographic survey and geotechnical investigation report which are under progress.

2.4 TOPOGRAPHY

Area within 10 Km Radius: Figure 2.3 shows the topography of the study area within ten Km radius. Elevation varies from 286 m in eastern part to 723 m in southern, south west and northern parts.

Plant Area: North part of the plant area has lowest elevation of 357.5 m whereas the South West part of the plant area has highest elevation of 388.9 m. The centre part of the plant area has an elevation of 380.5 meter. The North West part of the plant area has elevation in the range of 366.0 m 375.0 m. North Eastern part of the plant area has an elevation of 376 m to 380 m. These

elevations will provide a guideline for economizing the cost of earth work during the design of plant.

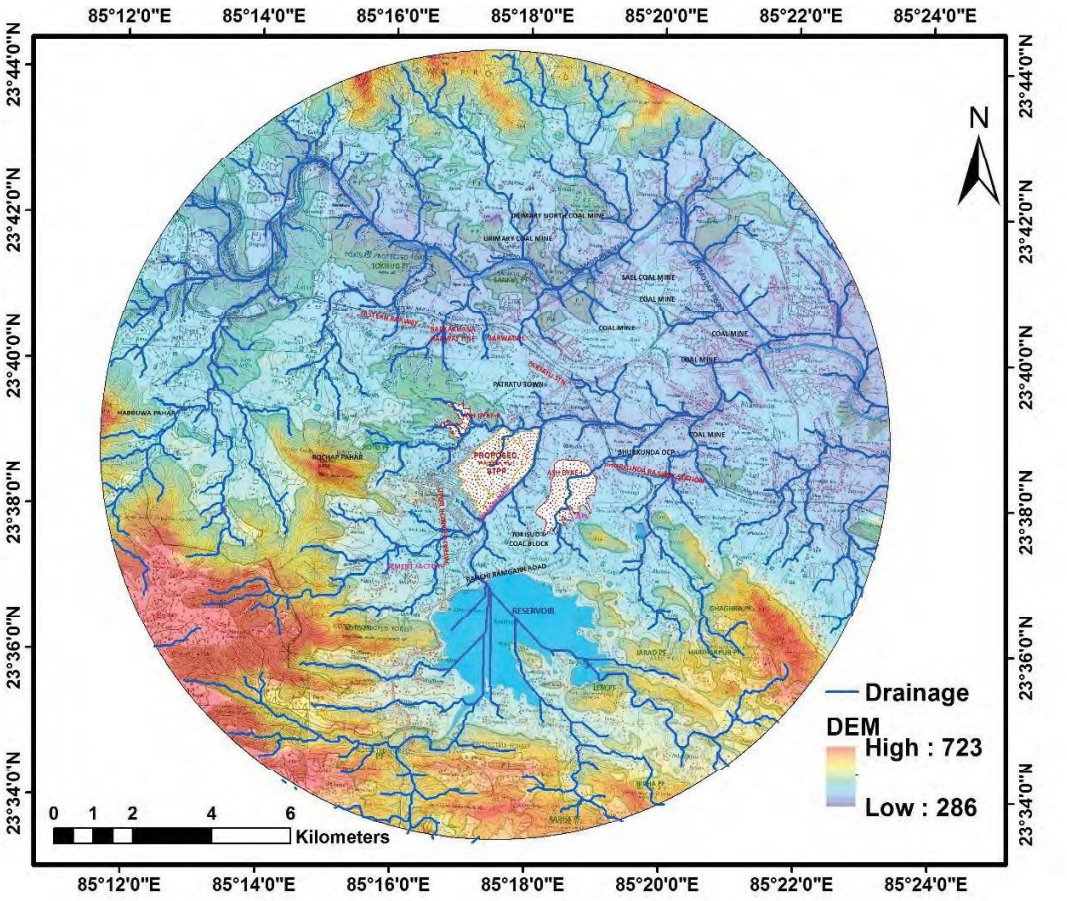

Figure 2.3: Topography and natural drainage in the study area within ten Km radius

2.5 NATURAL DRAINAGE

Figure 2.3 shows the natural drainage in study area within ten Km radius. The study area lies in the upper Damodar valley. Sources of water for the proposed and future thermal power plants are the existing reservoir at Patratu and runoff in tributary sub catchments in upper Damodar valley. Drainage pattern is in west to east direction in northern and central part of study area whereas it from south to north in southern part of study area.

Upper Damodar River is the main river in study area. The River Damodar originates near Rajruppa from the lava capped Khamarpat hill in Palamau district. In upper reaches it is known as Deonad. Traversing through the steep slopes of the hilly region, it descends on the flat plain of Chandwa basin. After the confluence with Dharamauti, the Damodar enters the Gondwana basin

and the landscape changes. The gradient of the stream becomes steeper and waterfalls abound the course of the stream. The river receives a number of tributaries in this section both from southern and northern slopes. The southern tributaries originating from Ranchi plateau are the Chati, the Dainkata, the Saphi (414 km^2), the Batuka, the Nalkari and the Dhobdhab. The northern tributaries originating from Hazaribagh plateau are the Ramghat – Haharo (570 km^2), the Marmahar (130 km^2), the Konar (1295 km^2), and the Bokaro (595 km^2).

Nalkari River is a right bank tributary of Upper Damodar river. Average annual rainfall in the catchment is 1270 mm. The Nalkari river attained the maximum flood level of 367.5 m near Patratu power plant site in the year 1958 i.e. prior to construction of the Nalkari dam.

The Nalkari Reservoir: A dam has been constructed on Nalkari River near village Patratu in Ramgarh District. Figure 2.4 schematically depicts the size of Nalkari dam and the reservoir. The dam was constructed during the period 1962-1968 and it is now more than 50 years old. Catchment area of the reservoir is 212.38 sq. km (81.32 sq miles).The reservoir is located between Latitude $23^0$36'13''N to $23^0$36'18''N and Longitude $85^0$16'50''N to 85018'54''N. Earthen non overflow section (on right and left flank) of the dam is 10376 ft long and masonry overflow section (spillway) is 320 ft long. The Nalkari reservoir is near to the Mourya coal field (13.87 km), railway line (4.62 km) and National Highway 23 (22.73 km). Gegde is the nearest village (2.98 km).

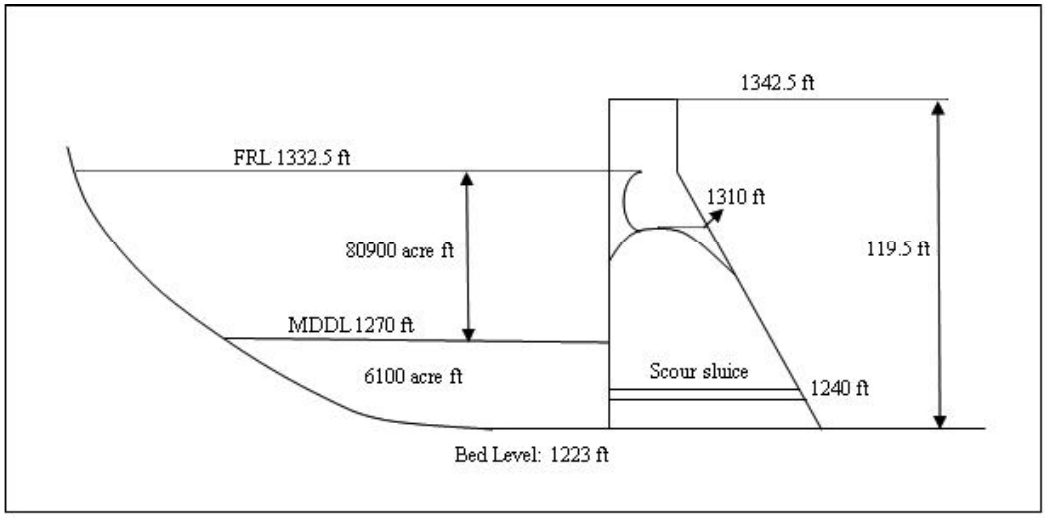

Figure 2.4: Size of the Nalkari dam and reservoir

Natural Drainage in vicinity of Plant Area and Ash Dykes

Nalkari River: The existing Patratu power plant and the proposed plant lie in the adjacent to Nalkari river in downstream of the Nalkari reservoir

Tilaiyatar nala : It passes through the ash dyke-II area. The Tilaiyatar nala joins Nalkari river on its left bank.

SY nala: Another nala passes through the proposed site of main plant area. It is named SY nala for the sake of discussion. SY nala joins the Tilaiyatar nala coming from Ash dyke–II area.

Purnatoli nala: A nala passes through the ash dyke-I area. Ash Dyke-I area lies on the right bank side of Nalkari river. The Purnatoli nala joins Nalkari river on its right bank

2.6 SOIL TYPE

CIMFR (2015) have carried out soil analysis of samples from the sapling locations in upstream and downstream of ash pond. The sampling and soil testing were carried out six times in the year 2014(in the months of February, April, June, August, October and December, 2014. The analysis shows that soil type is sandy loam. Soil parameters are given in table 2.2.

Table 2.2: Soil Parameters

PARAMETER	SOIL IN U/S AREA	SOIL IN D/S AREA
SAND (%)	58-66.2	51.2-59.1
SILT (%)	14.8-19.8	17.8-21.8
CLAY (%)	13.5-17.2	12.8-18.1
BULK DENSITY (%)	1.25-1.66	1.27-1.83
MOISTURE CONTENT (%)	2.3-3.6	2.9-4.2
WATER HOLDING CAPACITY (%)	20.6-23.18	22.14-24.17

2.7 LAND USE /LAND COVER MAP

Land use and land cover map was prepared using remote and GIS techniques. For this purpose, cloud free Landsat 8 OLI geocoded imageries of 19th December 2015 having eleven spectral bands were collected from USGS earth explorer. The satellite image was classified using supervised classification with maximum likelihood classification algorithm by visual

interpretation in ERDAS IMAGINE Software, which along with ARC GIS was used for generation of land use/land cover map. The spatial distribution of land use and land cover analysis for the area is provided in table 2.3. Figure 2.5 shows the land use land cover in study area. The area is mainly occupied by Dense Forest (28.54 %), Agriculture (23.41 %), Fallow land (19.80 %), Open Forest (13.84 %), Waste land (6.63 %), Settlement (4.06 %) and Water body (3.72 %).

Table 2.3: Areas under different land use/ land cover classes

Sl. No.	LULC	No. of Pixels	Area(ha)	Area (%)
1	Dense Forest	99630	8966.7	28.54
2	Waterbody	12991	1169.19	3.72
3	Agriculture	81701	7353.09	23.41
4	Open Forest	48301	4347.09	13.84
5	Waste Land	23145	2083.05	6.63
6	Settlement	14179	1276.11	4.06
7	Fallow Land	69124	6221.16	19.80
Total			**31416.39**	**100**

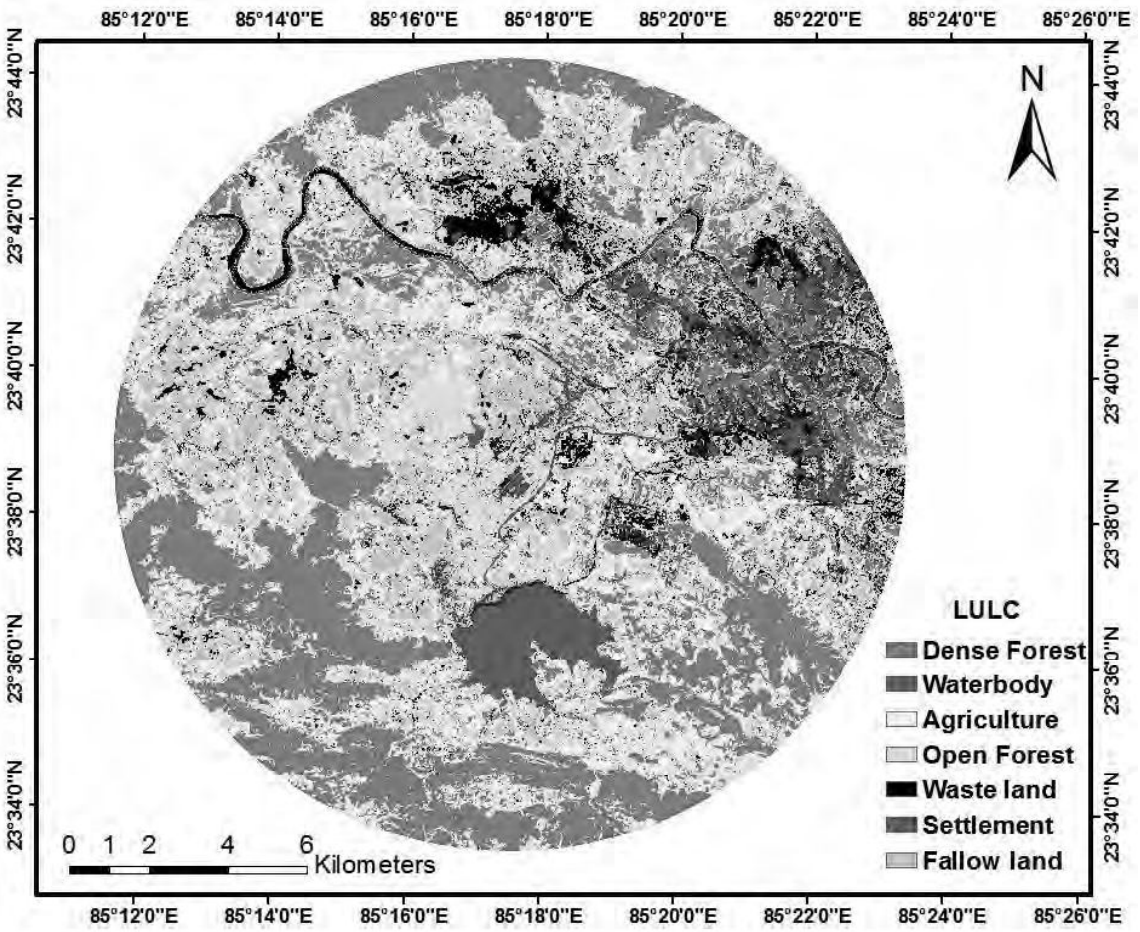

Figure 2.5: Land use / Land cover map of study area

2.8 CLIMATE

The area lies in the sub-humid region of Chotanagpur Plateau and enjoys semi-extreme type of climate. The day temperature rises around 40 °C during the summers and drops down to around 10 °C during the winter. Three broad seasons can be recognized; the winter season(November to February); the hot season(March to May) and the rainy season(June to October).The average annual rainfall in Ramgarh district is 1251.2 mm More than 80% of the precipitation is received during the monsoon months.

CHAPTER 3

DIGITAL ELEVATION MODEL STUDY

3.1 INTRODUCTION

Digital elevation model (DEM) is the digital representation (digital map) of the ground elevation data in meters. This digital map, a type of Digital Terrain Model (DTM) is raster data that it is made up of equally sized grid cells each with a unique elevation.

The projection and datum for a DEM may vary. In the present study, Polyconic coordinates (meters) have been used for geo-referencing of all maps. The following data have been used for DEM study:

i) Contour map of the plant area with contour interval of 0.50 m. This map has been prepared using recent grid survey data of the plant area.

ii) Geographic referencing points: These have been extracted from the features common in the toposheet and the map based on recent topographic survey and georeference points provided by M/S NTPC Limited.

iii) Survey of India Toposheet (1: 50000 scale): Toposheet Number 73 E/2 and 73 E/6 of year 1978-79.

iv) Plant layout map showing location and ground formation levels of various components of the Patratu Super Thermal Power Project (STPP) Phase-I(3 × 800 MW).

3.2 PROCEDURE FOR DIGITAL ELEVATION MODEL (DEM)

ARC-GIS software has been used for preparation of the DEM. Each contour was assigned its value and converted into TIN.

Different component of the Patratu Super Thermal Power Project (STPP) are shown in Figure 3.1

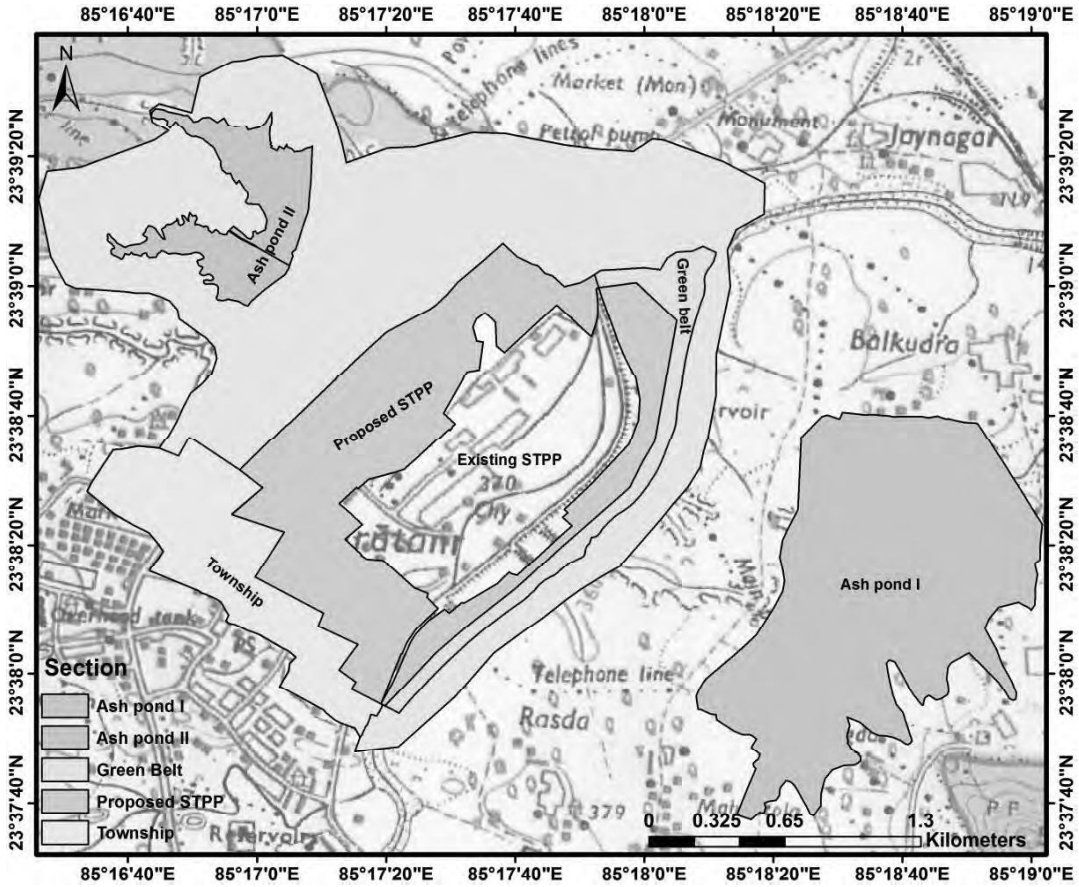

Figure 3.1: Different components of the Patratu Super Thermal Power Project (STPP)

The contours in shape file have been interpolated to obtain digital elevations of the equally sized gird cells. Size of a grid cell is 0.5 m × 0.5 m in this study. The DEM of the study area i.e. plant, ash pond 2 is shown as contour zoning map in Figure 3.2 and elevation variation from 349.18 m to 396.23 m is depicted through different colours. The DEM of the study area is also shown as single colour intensity map in Figure 3.2b.The DEM of the plant and ash pond is also presented separately in Figure 3.3 and Figure 3.4 respectively.

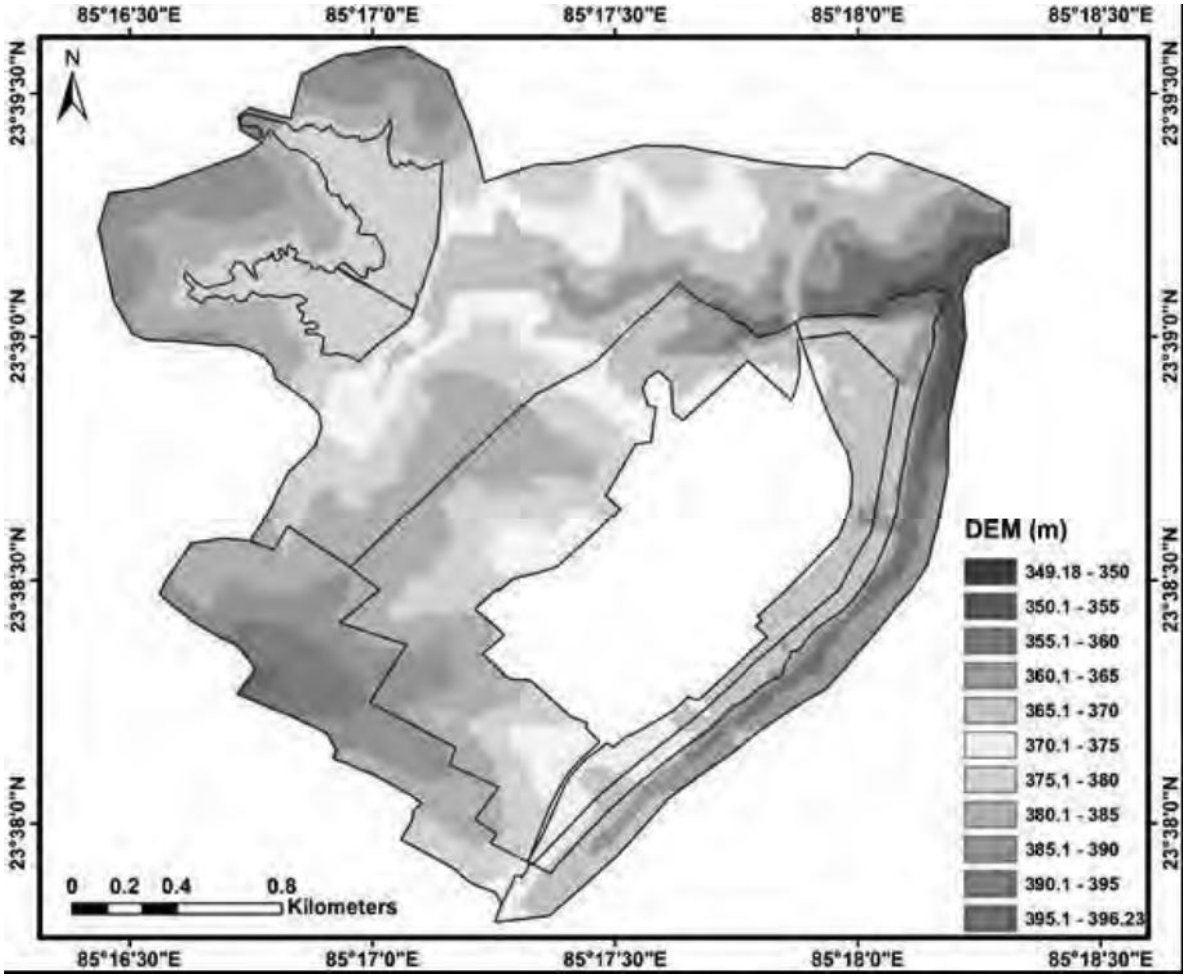

Figure 3.2a: DEM - contour zonation map of the study

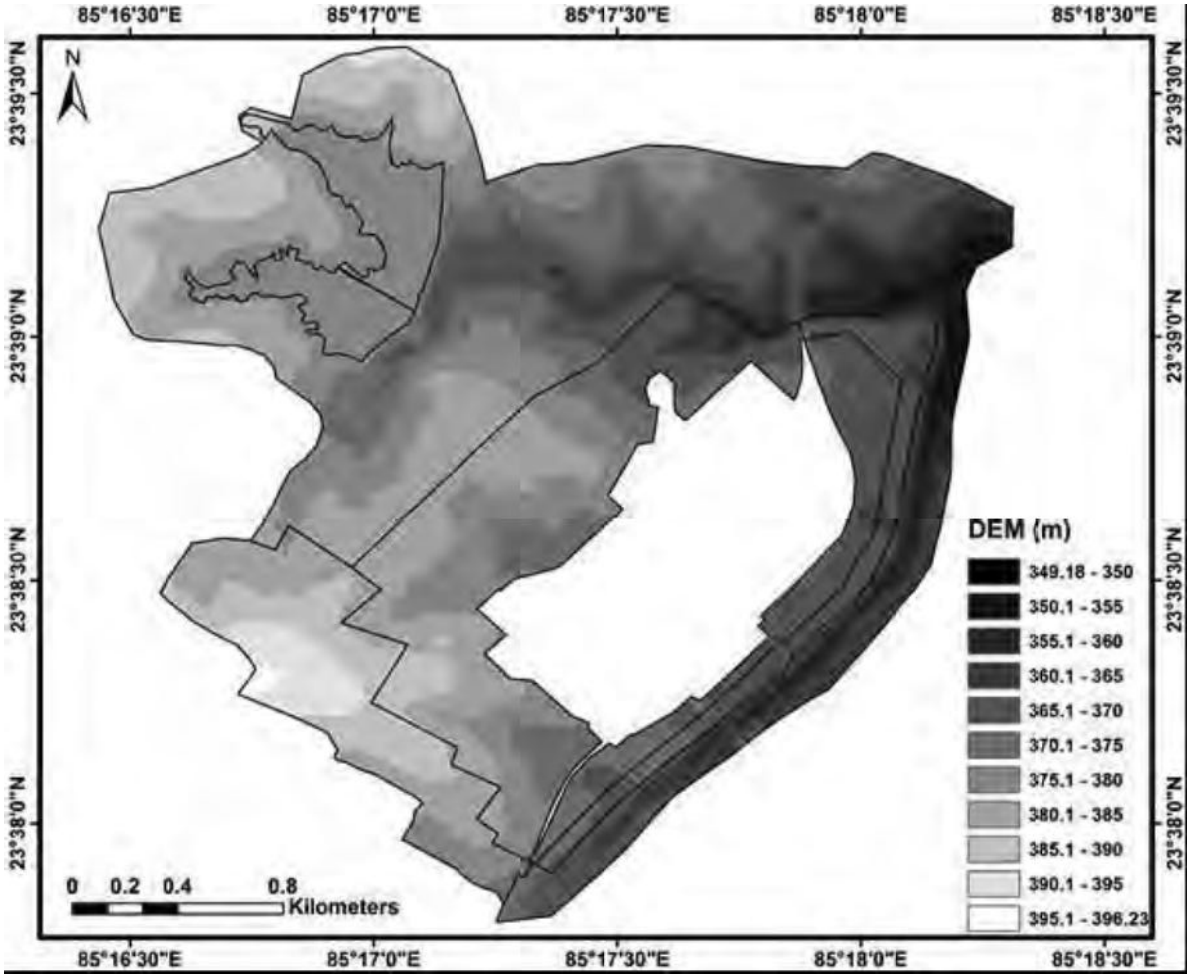

Figure 3.2b: DEM - terrain colour intensity map of the study area

3.2.1 DEM of the plant area

Figure 3.3 show that the North part of the study area has lowest elevation of 357.5 m. The centre part of the study area has an elevation of 380.5 meter. The South West part of the study area has highest elevations of 388.9 m. The North West part of the study area has elevation in the range of 366.0 m to 375.0 m. North Eastern part of the study area has an elevation of 376 m to 380 m. These elevations will provide a guideline for economizing the cost of earth work during the design of plant.

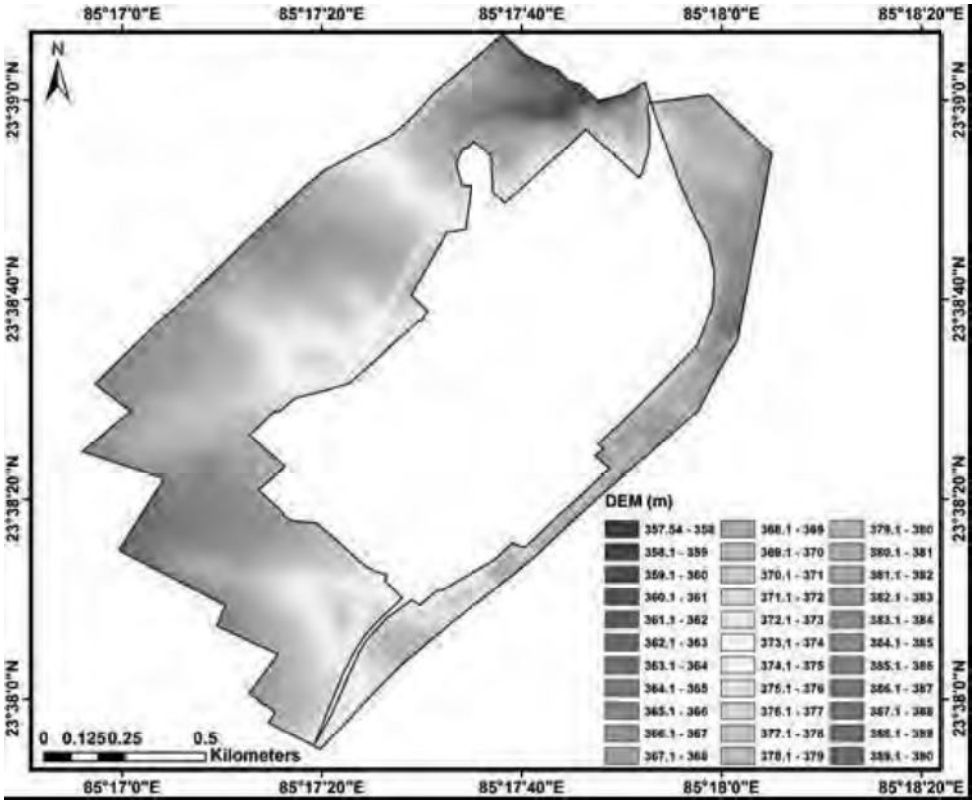

Figure 3.3: DEM - contour zonation map of the plant area

3.2.2 DEM of the ash pond area

3.2.2a DEM of the ash pond area 2

Figure 3.4a show that the north eastern part of the Ash pond area has lowest elevation of 376 m. The North western part of the study area has highest elevation of 388 m. These elevations will provide a guideline for economizing the cost of earth work during the design of Ash pond.

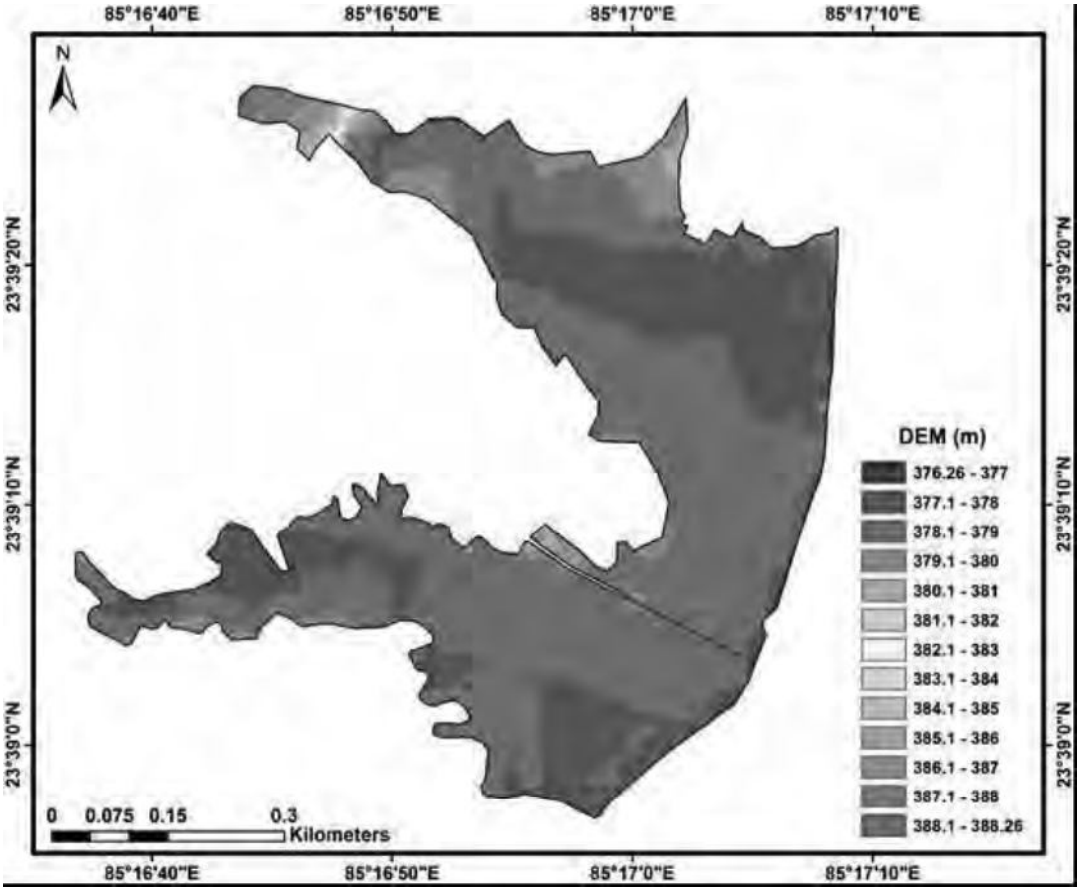

Figure 3.4a: DEM - contour zonation map of the ash pond 2 area using surveyed topographical data

3.2.2b DEM of the ash pond 1

Figure 3.4b show the variation in elevation from 356 m to 391 m in the ash pond 1 area. North-eastern part of the Ash pond area has lowest elevation of 356.0 m. The south-eastern part of the ash pond area has highest elevation of 391 m.

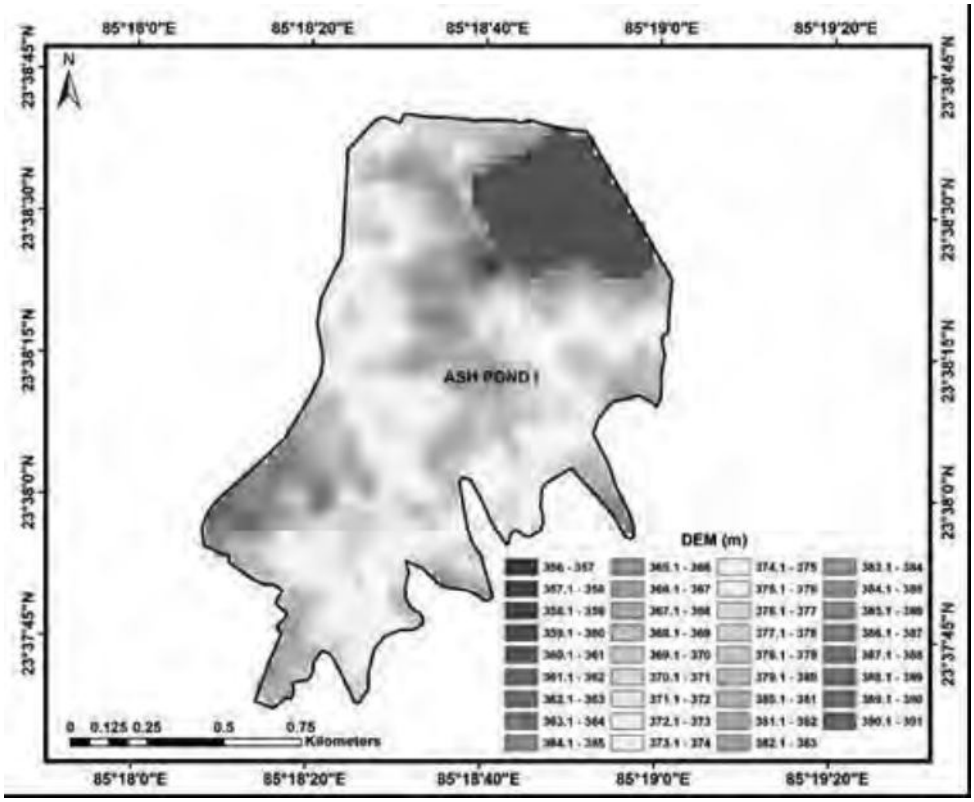

Figure 3.4b: DEM - contour zonation map of the ash pond 1 area using SRTM DEM datasets

3.2.3 DEM of the Green belt area

Figure 3.5 show that the southern part of the Green belt area has highest elevation of 374 m. The Northern part of the study area has lowest elevation of 350 m.

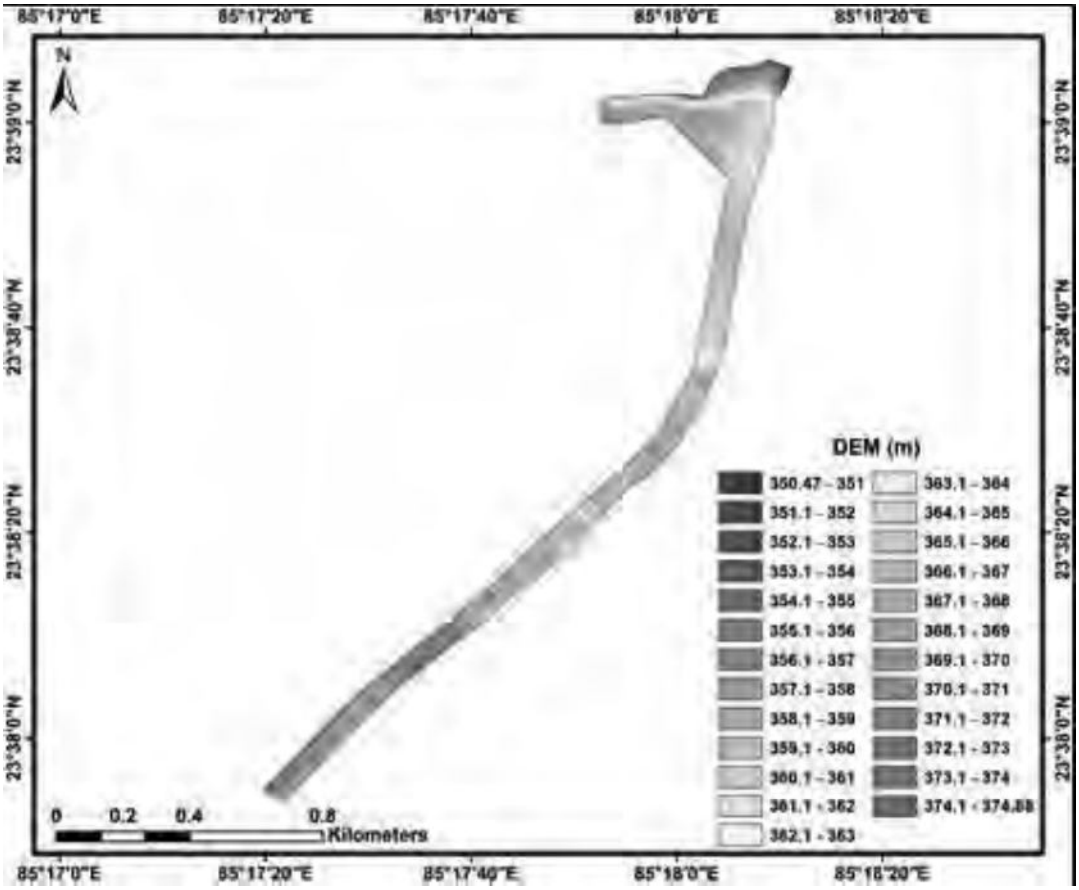

Figure 3.5: DEM - contour zonation map of the Green belt area

3.2.4 DEM of the colony area

Figure 3.6 show that the north eastern part of the colony area has lowest elevation of 372 m. The South western part of the study area has highest elevation of 395 m.

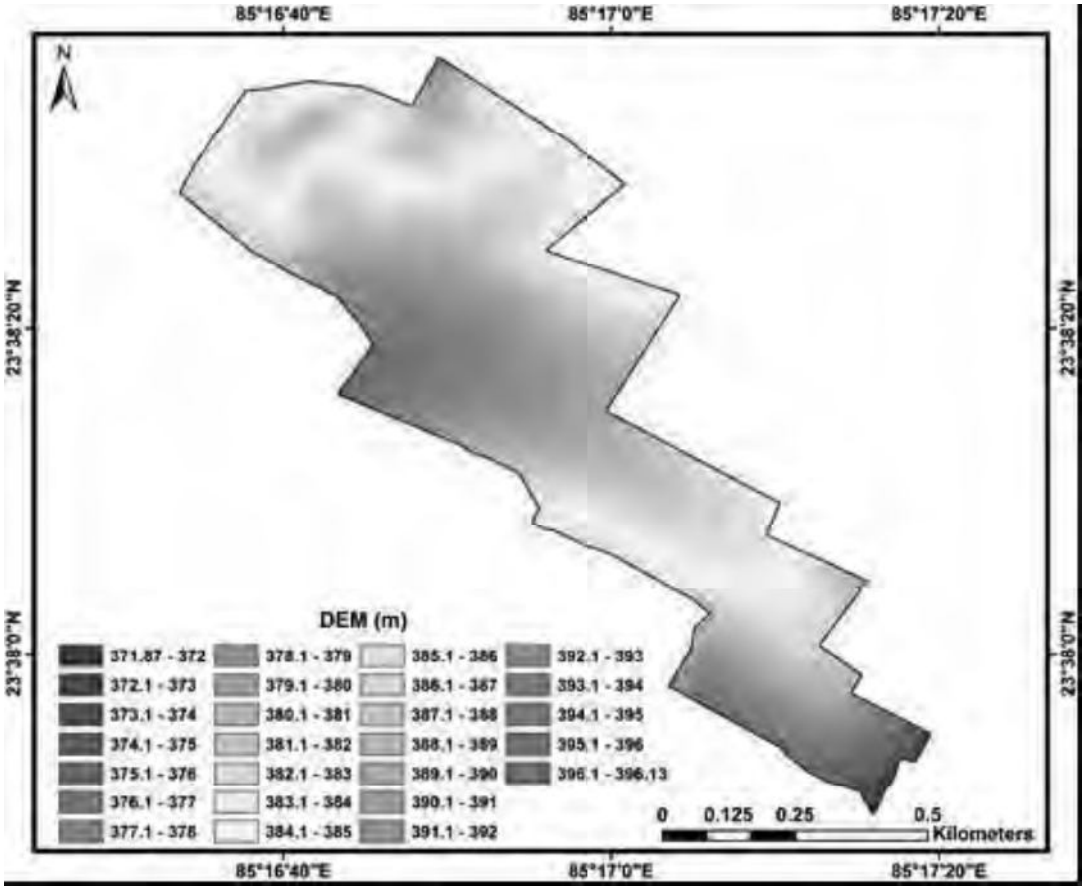

Figure 3.6: DEM - contour zonation map of the Colony area

3.3 GENERATION OF STREAM NETWORK

The Spatial analyst tools of ARC-GIS software has been used in the present study for further processing in the context of stream generation.

DEM has been smoothened out for eliminating uneven irregularities using Fill tool to remove the sinks. Corrected DEM has been used to generate pattern of flow directions and for identification of flow accumulation through each pixel of given elevation. Generated information on flow pattern and flow accumulation considers Eight-Point Pour model for the purpose of computing flow directions for use in basin delineation with DEMs directions. With the flow directions assigned for each DEM point, the flow accumulation at each DEM point has been computed. The flow accumulation at a given DEM point is defined as the number of earlier DEM points whose flow paths eventually pass through that point.

Streams are identified by large values of flow accumulation since the flow paths of many points pass through the stream points. Outlet of a watershed has the highest value of flow

accumulation of any of the DEM points since the flow paths of all points in the watershed will eventually pass through the outlet point. Streams have been identified by displaying all DEM points with a flow accumulation value of more than 500. Figure 3.7a and b shows the generated stream network in the study area.

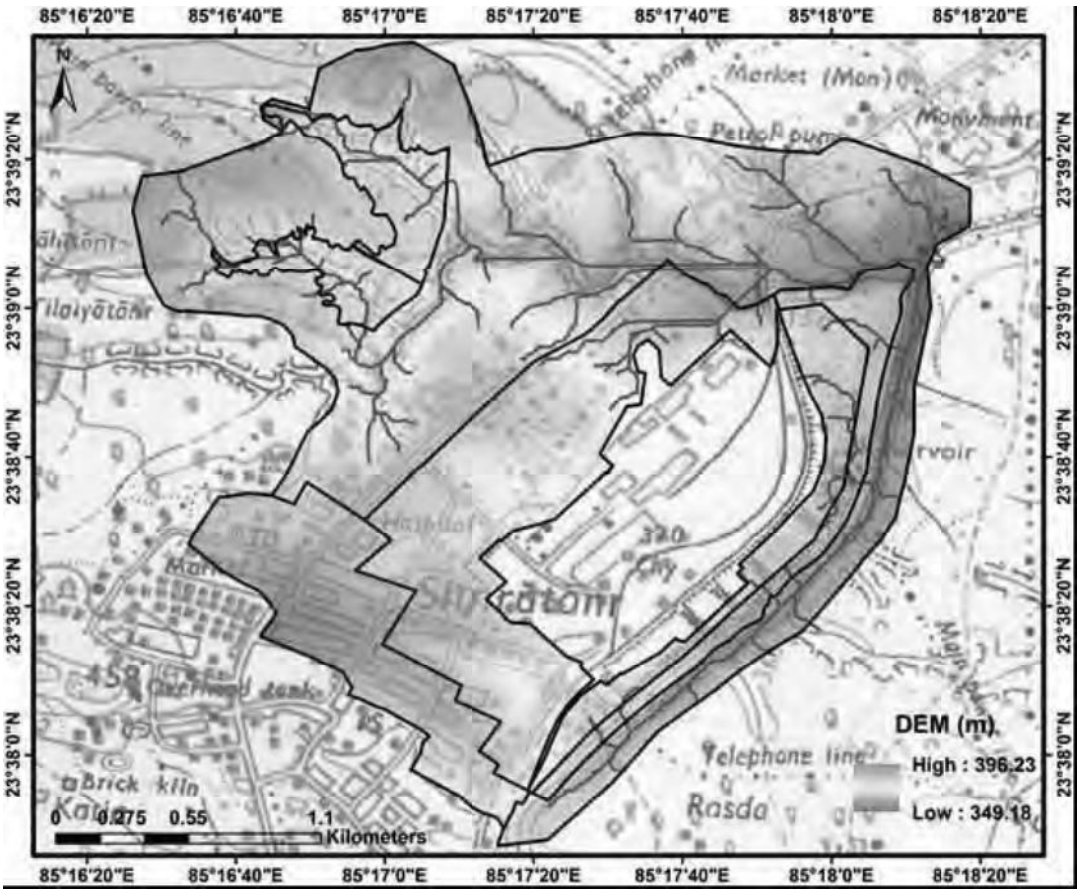

Figure 3.7a: Drainage network derived from DEM

Drainage network created from DEM was overlaid with the toposheet drainage network (Figure 3.7 b). It is evident from the Figures 3.7 that major drainage of the study area is matching with the drainage created from DEM. Drainage of the area has not much changed over the time period. Overlaid DEM and toposheet is also presented in Fig.3.7c.

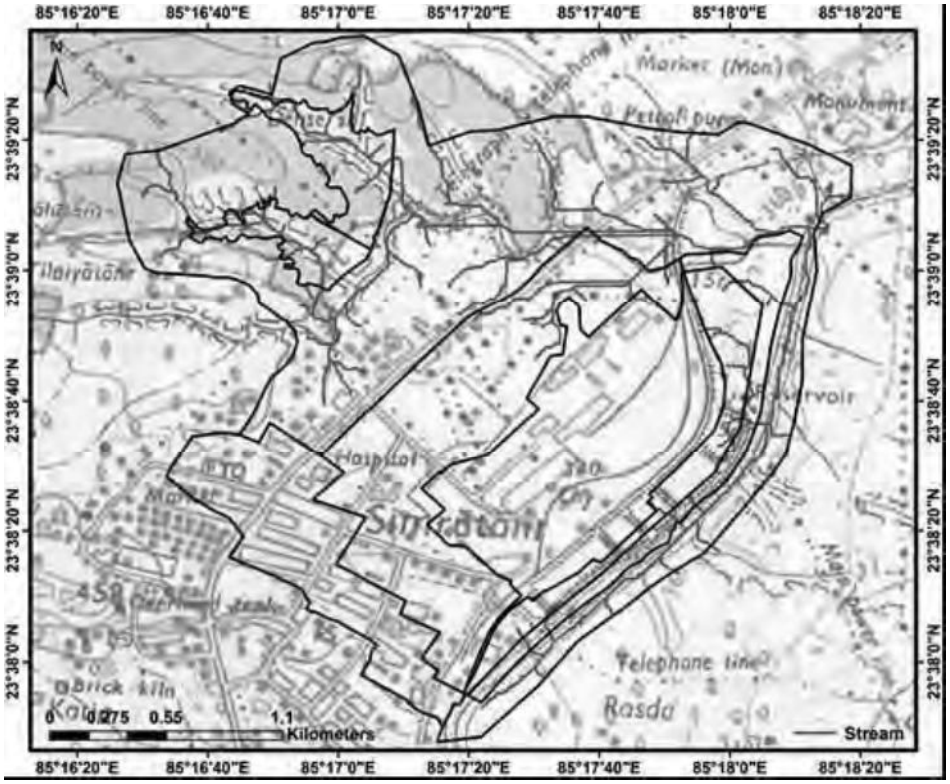

Figure 3.7b: Comparisons of drainage network from toposheets drainage

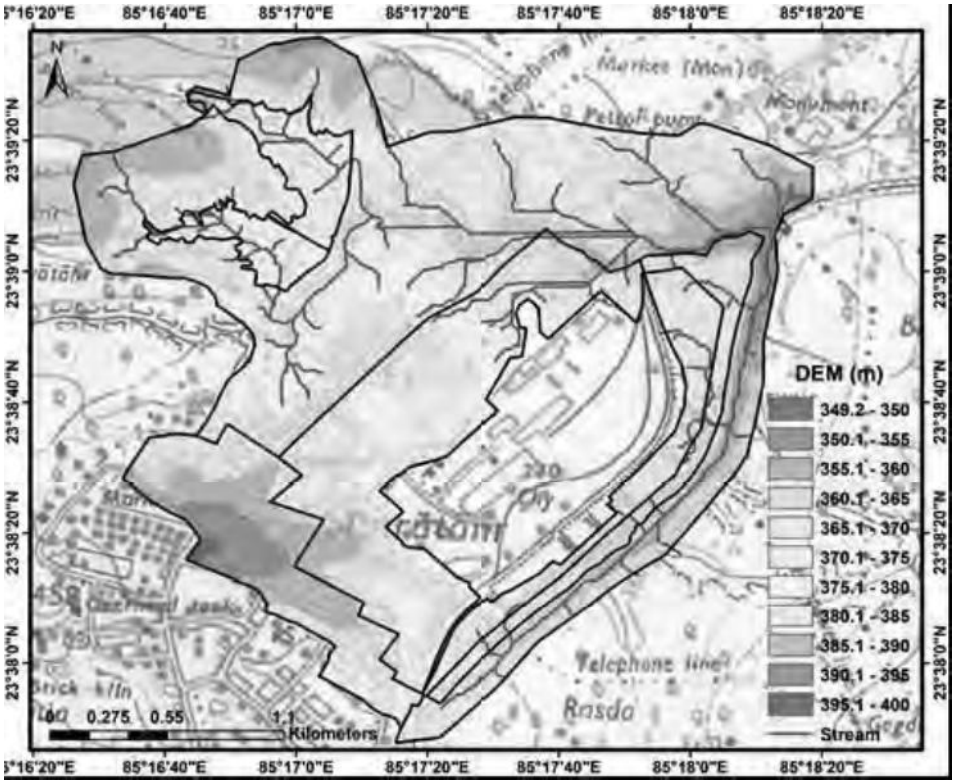

Figure 3.7c: Overlay of DEM and toposheets

3.4 DISTRIBUTION OF LAND AREA IN DIFFERENT ELEVATION

3.4.1 PLANT AREA

The Digital Elevation Model prepared in ARC-GIS has been used to compute the natural drainage area (within plant boundaries) between different elevation ranges. The DEM computes the number of pixels in each interval. Table 3.1 shows distribution of area from 357.54 m to 389 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m.

67.65 ha (50.15%) of the plant area lies below 376.0 m elevation and the plant area having elevation higher than 379 m elevation is ha (34.43%).

Table 3.1: Areal distribution with elevation in the plant area and reservoir as per DEM

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
358	361	90.25	0.01	0.01	0.01	0.01
359	5693	1423.25	0.14	0.11	0.11	0.15
360	17272	4318.00	0.43	0.33	0.44	0.58
361	21501	5375.25	0.54	0.41	0.84	1.12
362	33874	8468.50	0.85	0.64	1.48	1.97
363	38924	9731.00	0.97	0.73	2.22	2.94
364	45444	11361.00	1.14	0.86	3.07	4.08
365	57049	14262.25	1.43	1.07	4.15	5.50
366	97214	24303.50	2.43	1.83	5.98	7.93
367	176104	44026.00	4.40	3.32	9.30	12.34
368	272948	68237.00	6.82	5.14	14.44	19.16
369	374621	93655.25	9.37	7.06	21.50	28.53
370	298995	74748.75	7.47	5.63	27.13	36.00
371	170549	42637.25	4.26	3.21	30.35	40.26
372	235944	58986.00	5.90	4.45	34.79	46.16
373	180290	45072.50	4.51	3.40	38.19	50.67
374	215869	53967.25	5.40	4.07	42.26	56.07
375	250624	62656.00	6.27	4.72	46.98	62.33
376	212527	53131.75	5.31	4.00	50.98	67.65
377	222085	55521.25	5.55	4.18	55.17	73.20
378	235268	58817.00	5.88	4.43	59.60	79.08
379	316816	79204.00	7.92	5.97	65.57	87.00
380	319969	79992.25	8.00	6.03	71.60	95.00
381	323509	80877.25	8.09	6.10	77.69	103.09
382	335918	83979.50	8.40	6.33	84.02	111.48
383	314024	78506.00	7.85	5.92	89.94	119.33

384	207752	51938.00	5.19	3.91	93.85	124.53
385	128687	32171.75	3.22	2.42	96.28	127.75
386	92020	23005.00	2.30	1.73	98.01	130.05
387	51723	12930.75	1.29	0.97	98.99	131.34
388	34038	8509.50	0.85	0.64	99.63	132.19
389	18628	4657.00	0.47	0.35	99.98	132.66
389.44	1122	280.50	0.03	0.02	100.00	132.68
Total			132.68	100.00		

Figure 3.8 is graphical depiction of the cumulative area distribution up to different elevation in the plant area. The information derived from the DEM study can be used to arrive at cost effective levels at which different plant components should be finally located. It is recommended that in detailed project planning this aspect may be carefully examined.

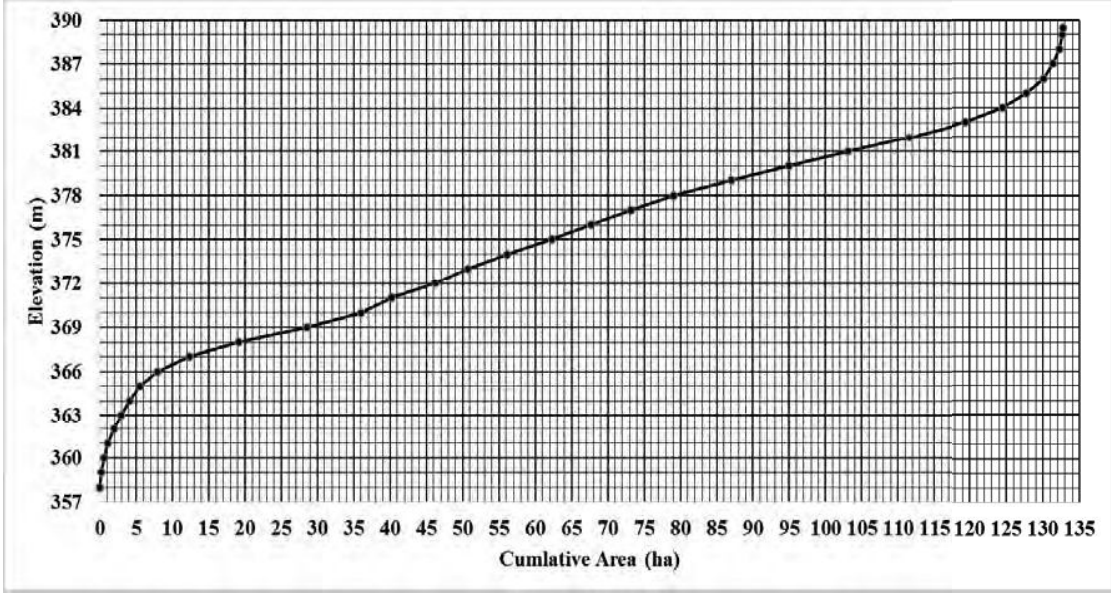

Figure 3.8: Cumulative areal distributions with elevation in plant area

3.4.2a ASH POND (II)

Table 3.2 shows distribution of area in the Ash Pond area from 376.1 m to 388.26 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.9 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.2: Areal distribution with elevation in the Ash Pond area as per Survey data

Elevation (m)	No. of Pixel	Area (sq. m)	Area (ha)	Area (%)	Cumulative Area (%)	Cumulative Area (ha)
376.10	3247	811.75	0.08	0.25	0.25	0.08
378.00	373864	93466.00	9.35	29.20	29.46	9.43
379.00	795643	198910.75	19.89	62.15	91.61	29.32
380.00	72209	18052.25	1.81	5.64	97.25	31.12
381.00	9885	2471.25	0.25	0.77	98.02	31.37
382.00	1081	270.25	0.03	0.08	98.11	31.40
383.00	1082	270.50	0.03	0.08	98.19	31.43
384.00	874	218.50	0.02	0.07	98.26	31.45
385.00	1762	440.50	0.04	0.14	98.40	31.49
386.00	4255	1063.75	0.11	0.33	98.73	31.60
387.00	5515	1378.75	0.14	0.43	99.16	31.74
388.00	9781	2445.25	0.24	0.76	99.93	31.98
388.26	953	238.25	0.02	0.07	100.00	32.00
			32.00			100.00

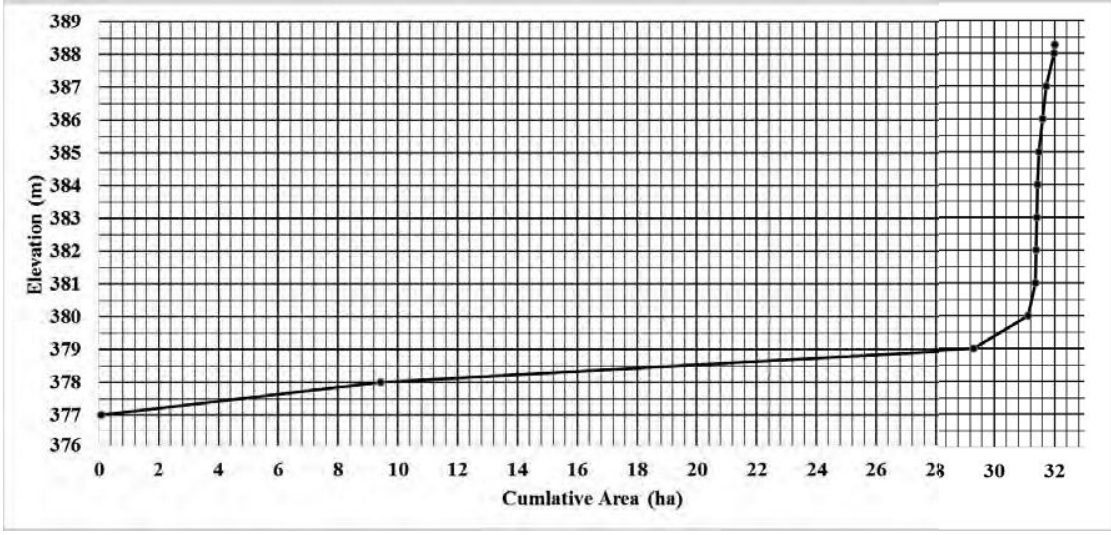

Figure 3.9: Cumulative areal distributions with elevation in ash pond 2 area

3.4.2b ASH POND (I)

Table 3.3 shows distribution of area in the Ash Pond area from 356 m to 391 m elevation. The DEM pixel size used in this study is 30 m × 30 m. Figure 3.10 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.3: Areal distribution with elevation in the Ash Pond 1 area as per SRTM DEM

Elevation	No. of Pixel	Area (sq. m)	Area (ha)	Area %	Cumulative Area (%)	Cumulative Area (ha)
356	1	867.64	0.09	0.05	0.05	0.09
360	221	191747.78	19.17	11.84	11.90	19.26
361	4	3470.55	0.35	0.21	12.11	19.61
362	5	4338.19	0.43	0.27	12.38	20.04
363	2	1735.27	0.17	0.11	12.49	20.22
364	3	2602.91	0.26	0.16	12.65	20.48
365	20	17352.74	1.74	1.07	13.72	22.21
366	41	35573.12	3.56	2.20	15.92	25.77
367	80	69410.96	6.94	4.29	20.20	32.71
368	89	77219.70	7.72	4.77	24.97	40.43
369	93	80690.24	8.07	4.98	29.96	48.50
370	113	98042.98	9.80	6.06	36.01	58.31
371	126	109322.27	10.93	6.75	42.77	69.24
372	121	104984.08	10.50	6.48	49.25	79.74
373	118	102381.17	10.24	6.32	55.57	89.97
374	159	137954.29	13.80	8.52	64.09	103.77
375	106	91969.53	9.20	5.68	69.77	112.97
376	93	80690.24	8.07	4.98	74.76	121.04
377	95	82425.52	8.24	5.09	79.85	129.28
378	53	45984.76	4.60	2.84	82.69	133.88
379	69	59866.96	5.99	3.70	86.39	139.86
380	60	52058.22	5.21	3.22	89.60	145.07
381	50	43381.85	4.34	2.68	92.28	149.41
382	33	28632.02	2.86	1.77	94.05	152.27
383	23	19955.65	2.00	1.23	95.28	154.27
384	11	9544.01	0.95	0.59	95.87	155.22
385	26	22558.56	2.26	1.39	97.27	157.48
386	19	16485.10	1.65	1.02	98.29	159.12
387	12	10411.64	1.04	0.64	98.93	160.17
388	6	5205.82	0.52	0.32	99.25	160.69
389	5	4338.19	0.43	0.27	99.52	161.12
390	7	6073.46	0.61	0.38	99.89	161.73
391	2	1735.27	0.17	0.11	100.00	161.90
			161.90			

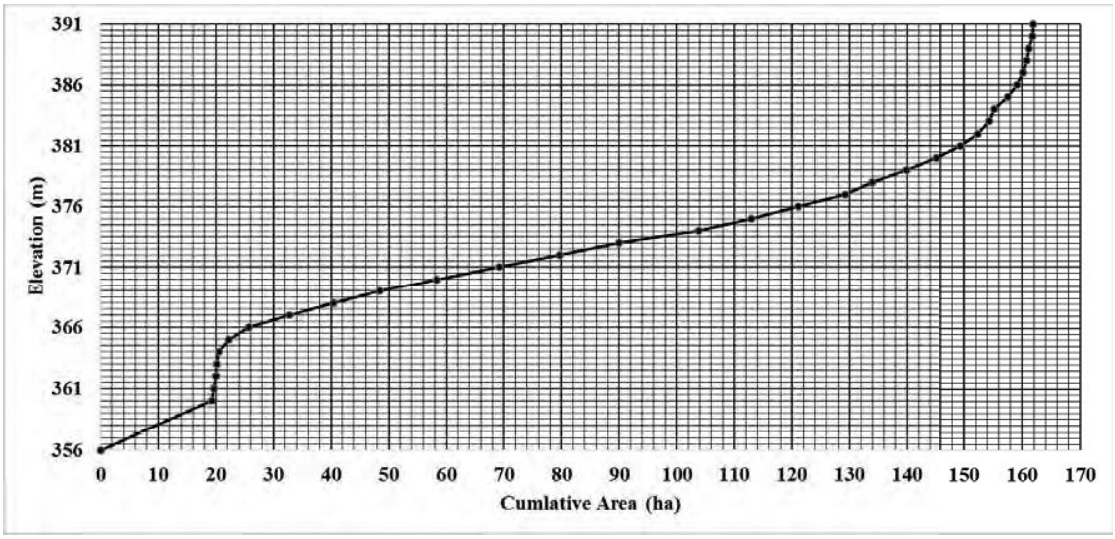

Figure 3.10: Cumulative areal distributions with elevation in ash pond 1 area

3.4.3 COLONY AREA

Table 3.4 shows distribution of area in the Colony area from 371.87 m to 396.23 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.11 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.4: Areal distribution with elevation in the Colony area

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
371.87	336	84.00	0.01	0.01	0.01	0.01
373	6527	1631.75	0.16	0.29	0.30	0.17
374	10651	2662.75	0.27	0.47	0.77	0.44
375	17647	4411.75	0.44	0.77	1.54	0.88
376	26371	6592.75	0.66	1.16	2.70	1.54
377	44870	11217.50	1.12	1.97	4.67	2.66
378	48285	12071.25	1.21	2.12	6.79	3.87
379	46981	11745.25	1.17	2.06	8.85	5.04
380	42152	10538.00	1.05	1.85	10.70	6.10
381	66204	16551.00	1.66	2.90	13.60	7.75
382	103746	25936.50	2.59	4.55	18.15	10.34
383	177973	44493.25	4.45	7.81	25.96	14.79
384	221354	55338.50	5.53	9.71	35.67	20.33
385	210134	52533.50	5.25	9.22	44.89	25.58
386	220603	55150.75	5.52	9.68	54.56	31.10

387	193823	48455.75	4.85	8.50	63.07	35.94
388	150908	37727.00	3.77	6.62	69.69	39.71
389	121915	30478.75	3.05	5.35	75.04	42.76
390	110492	27623.00	2.76	4.85	79.88	45.52
391	110216	27554.00	2.76	4.83	84.72	48.28
392	102170	25542.50	2.55	4.48	89.20	50.83
393	85449	21362.25	2.14	3.75	92.95	52.97
394	63961	15990.25	1.60	2.81	95.75	54.57
395	52941	13235.25	1.32	2.32	98.08	55.89
396	42586	10646.50	1.06	1.87	99.94	56.96
396.23	1279	319.75	0.03	0.06	100.00	56.99
				100.00		

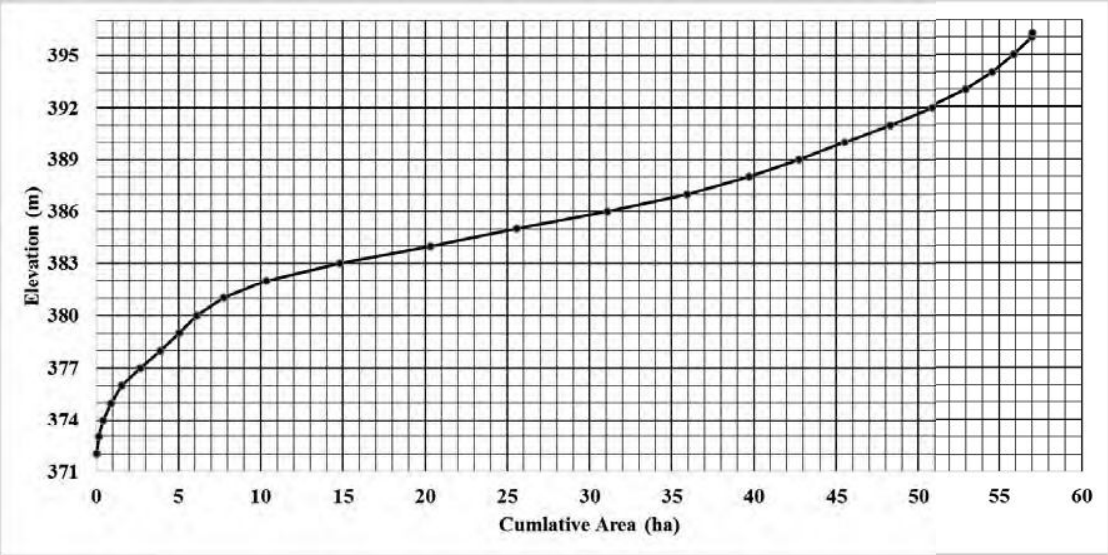

Figure 3.11: Cumulative areal distributions with elevation in colony area

3.4.4 GREEN BELT AREA

Table 3.5 shows distribution of area in the Ash Pond area from 350.47 m to 374.88 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.12 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.5: Areal distribution with elevation in the Green belt

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
350.47	372	93.00	0.01	0.04	0.04	0.01
352	2081	520.25	0.05	0.21	0.25	0.06
353	1438	359.50	0.04	0.15	0.40	0.10
354	3078	769.50	0.08	0.32	0.71	0.17
355	12430	3107.50	0.31	1.27	1.99	0.48
356	15674	3918.50	0.39	1.61	3.59	0.88
357	12719	3179.75	0.32	1.30	4.90	1.19
358	9845	2461.25	0.25	1.01	5.91	1.44
359	9656	2414.00	0.24	0.99	6.90	1.68
360	9680	2420.00	0.24	0.99	7.89	1.92
361	9270	2317.50	0.23	0.95	8.84	2.16
362	10855	2713.75	0.27	1.11	9.95	2.43
363	18342	4585.50	0.46	1.88	11.83	2.89
364	26879	6719.75	0.67	2.75	14.59	3.56
365	95753	23938.25	2.39	9.81	24.40	5.95
366	136165	34041.25	3.40	13.96	38.36	9.36
367	145399	36349.75	3.63	14.90	53.26	12.99
368	133970	33492.50	3.35	13.73	66.99	16.34
369	125766	31441.50	3.14	12.89	79.88	19.48
370	76728	19182.00	1.92	7.86	87.74	21.40
371	39388	9847.00	0.98	4.04	91.78	22.39
372	48349	12087.25	1.21	4.96	96.74	23.60
373	22022	5505.50	0.55	2.26	98.99	24.15
374	8637	2159.25	0.22	0.89	99.88	24.36
374.88	1196	299.00	0.03	0.12	100.00	24.39
Total			24.39			

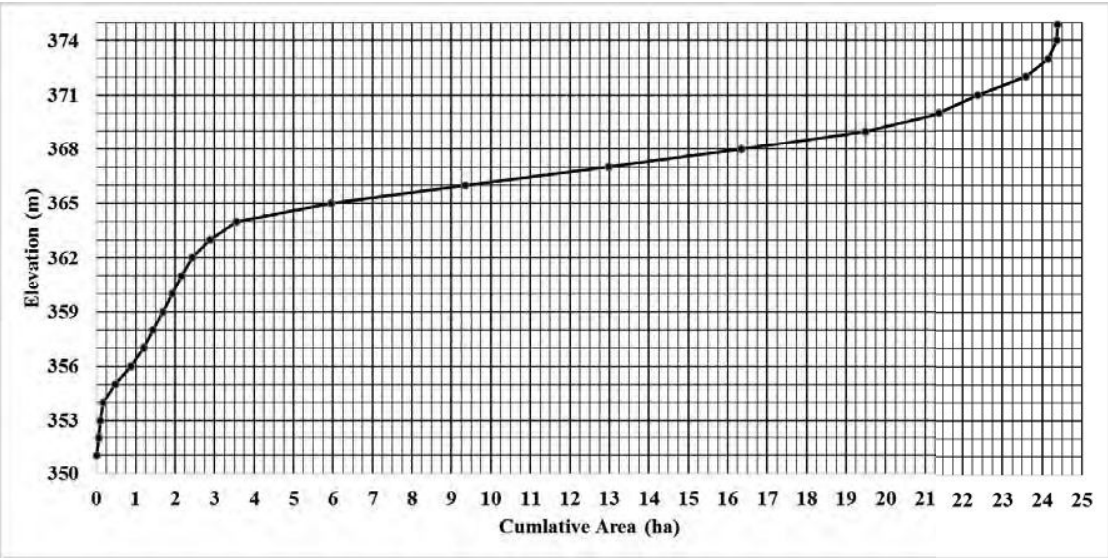

Figure 3.12: Cumulative areal distributions with elevation in Green belt area

CHAPTER 4

DESIGN STORM SCENARIOS OF VARIOUS RETURN PERIODS

Design storm and flood scenarios are required for (i) planning of drainage in the plant area and vicinity and (ii) for assessing possible submergence in the plant area from internal and external flooding.

The time distribution of storm rainfall of a given duration is the main input in deciding the flood peak and the shape of the flood hydrograph. This input has to be converted into excess rainfall and convoluted with synthetic unit hydrograph to obtain a flood hydrograph with addition of base flow. This chapter covers estimation of storm rainfall of various return periods.

4.1 FREQUENCY ANALYSIS OF 1-DAY ANNUAL MAXIMUM RAINFALL

Daily rainfall data are available at Ranchi from 1971 to 2011 (41 years). 1-Day annual maximum rainfall series was constructed and EV Type I probability distribution was applied (table 4.1a). Figure 4.1 shows graphical frequency analysis of 1-Day annual maximum rainfall at Ranchi.

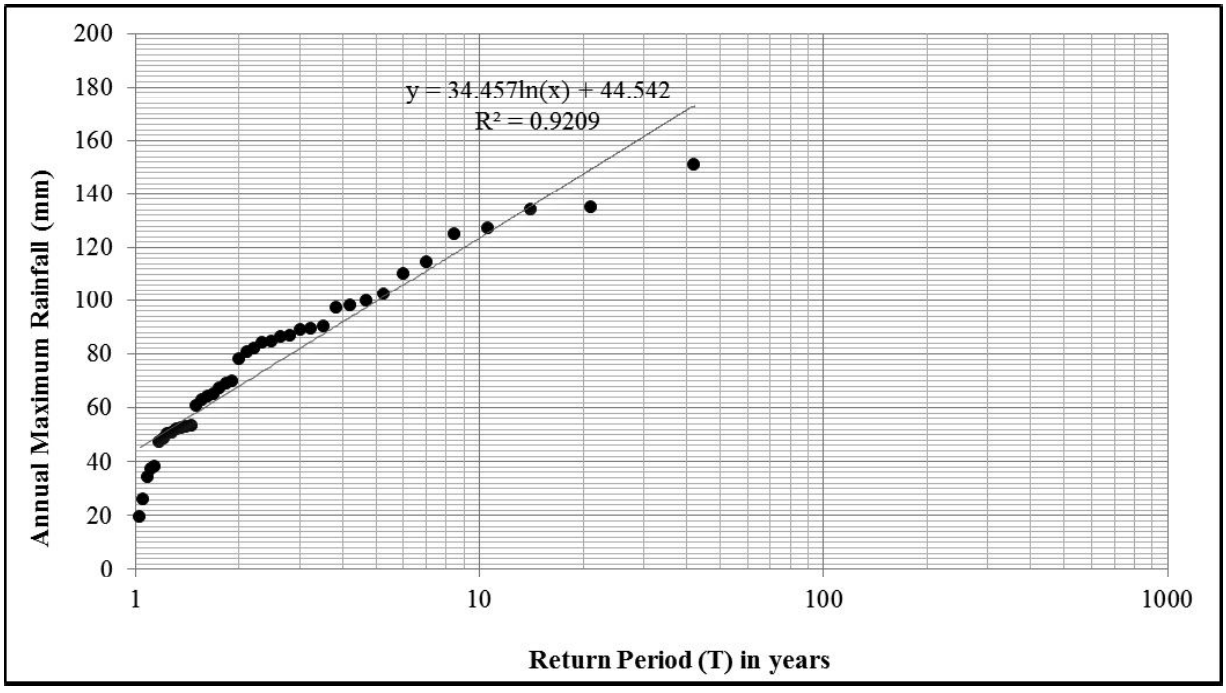

Figure 4.1: EV Type I Graphical frequency analysis of 1-Day annual maximum rainfall at Ranchi

1-Day rainfall has been converted to 24 hr rainfall using a factor of 1.15 (as per CWC report Nov.1994). 1-day rainfall and corresponding 24 hr rainfall for various return periods are given in table 4.1b.

Table 4.1a: Frequency analysis of rainfall data

Year	Maximum Rainfall (mm)	Rank	Probability of occurrence (P)	Return period (T)
1973	151.4	1	0.02	42.00
2008	135.2	2	0.05	21.00
1994	134.2	3	0.07	14.00
1998	127.5	4	0.10	10.50
2011	125.2	5	0.12	8.40
1999	114.9	6	0.14	7.00
1995	110.3	7	0.17	6.00
2009	102.6	8	0.19	5.25
1985	99.8	9	0.21	4.67
1988	98.4	10	0.24	4.20
1996	97.2	11	0.26	3.82
1971	90.4	12	0.29	3.50
2003	89.8	13	0.31	3.23
1976	89	14	0.33	3.00
2007	86.9	15	0.36	2.80
1989	86.6	16	0.38	2.63
1978	84.9	17	0.40	2.47
2006	84.4	18	0.43	2.33
1997	82.3	19	0.45	2.21
1980	80.9	20	0.48	2.10
1974	78.5	21	0.50	2.00
1993	70.2	22	0.52	1.91
1975	69.4	23	0.55	1.83
2004	67.6	24	0.57	1.75
1984	65.5	25	0.60	1.68
2002	64.6	26	0.62	1.62
1982	63.1	27	0.64	1.56
1972	61	28	0.67	1.50
1987	53.5	29	0.69	1.45
2000	53	30	0.71	1.40
1991	52.6	31	0.74	1.35
1983	52.3	32	0.76	1.31
2001	50.8	33	0.79	1.27
1981	50.6	34	0.81	1.24
1977	48.8	35	0.83	1.20
1986	47.3	36	0.86	1.17
1992	38.5	37	0.88	1.14
1990	37.7	38	0.90	1.11
1979	34.6	39	0.93	1.08
2010	26.1	40	0.95	1.05
2005	19.7	41	0.98	1.02