

VOLUME – IA

Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED



TECHNICAL CONDITIONS OF CONTRACT (TCC)

CONTENTS

S NO	DESCRIPTION	CHAPTER	NO OF PAGES
VOL I A	PART-I: CONTRACT SPECIFIC DETAILS		
1	Project Information	Chapter-I	2
2	Scope of works	Chapter-II	6
3	Facilities in Scope of Contractor / BHEL (Scope Matrix)	Chapter-III	15
4	T&Ps and MMEs to be deployed by Contractor	Chapter-IV	9
5	T&Ps and MMEs to be deployed by BHEL on sharing basis	Chapter-V	1
6	Time Schedule	Chapter-VI	5
7	Terms of Payment	Chapter-VII	4
8	Taxes and other Duties	Chapter-VIII	2
9	Bill of Quantity	Chapter-IX	1
10	General	Chapter-X	9
11	Accounting of materials	Chapter-XI	3
12	Progress of work	Chapter-XII	3
13	Material Handling	Chapter-XIII	2
VOL IA	PART-II: TECHNICAL SPECIFICATIONS		
1	Corrections / Revisions in Special Conditions of Contract	Chapter-1	4
2	Technical Specifications	Chapter-2	1201
3	Bid drawings	Chapter-3	01
4	Health, Safety and Environment Plan for Site Operation By Subcontractors	Chapter-4	82
5	Hire charges on issue of capital tools & Plants (Only corresponding charges)	Chapter-5	10

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART – I CHAPTER – I

PROJECT INFORMATION

1.1 INTRODUCTION

1.1.1 The scope of work covers Construction of twin steel flue RCC Chimney of 150 M height (excluding foundation) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL). The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

1.1.2 PROJECT INFORMATION

S NO.	DESCRIPTION	DETAILS
1	Name of the Project	Construction of twin steel flue RCC Chimney of 150 M height in existing 2 x 500 MW Tuticorin Thermal power station
2	Station Capacity	2X500 MW (Coal based)
3	Owner	NLC TAMILNADU POWER LIMITED (NTPL)
4	Site Location	At Tuticorin taluk in Tuticorin district in the southern part of Tamilnadu along the Bay of Munnar, India The site is accessed by National highway no. 7A adjacent to plant. Due south connecting Madurai.
5	Nearest Town	Nearest town is Tuticorin, which is located 5.5 km away from the plant

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S NO.	DESCRIPTION	DETAILS
6	Nearest City	Nearest city is Pallayamkottai, 60 km away from the plant
7	Nearest Railway Station	The nearest railway station is Port Trust Railway Yard at a distance of 1.0 km.
8	Nearest Airstrip	Nearest airstrip is located at Pudukottai at a distance of 16.5 km.
9	Nearest Sea Port	Tuticorin sea port is located adjacent to the plant.
10	Site Conditions	
	Ambient temperature	36.5 deg C Maximum 20.8 deg C Minimum
	Extreme Ambient temperature	36.4 deg C Maximum (Annual) 24.1 deg C Minimum (Annual)
	Relative Humidity	Maximum 82% Minimum 35% Average 57 to 68%
	Annual rainfall	437 mm
	Wind Load	In accordance with IS-875, Part-3 (Also refer Technical Specification)
	Seismic Zone	Zone-II as per IS: 1893 latest edition
	Altitude	1.46 M above MSL

VOLUME-IA PART – I CHAPTER – II

SCOPE OF WORKS

1.2 SCOPE OF WORKS

- 1.2.1 The scope covers Construction of twin steel flue RCC Chimney of 150 M height including all civil (excluding foundation work), structural, insulation, installation of borosilicate lining works, painting, electrical and elevator works of 2x500 MW Thermal Power Project site, including supply of all materials, labour, tools and plants. **(Cement & Reinforcement steel for civil works, Structural steel for structural works and borosilicate glass blocks for borosilicate lining system shall be provided by BHEL free of cost only for incorporation in the permanent work of the subject tender.**

Note: Structural required for embedments/ inserts will not be provided by BHEL).

The broad scope of work is Construction of twin steel flue RCC Chimney of 150 M height including all civil (excluding foundation), structural, insulation, painting, supply & installation of electrical works & elevators incl. supply of mandatory Spares & special and associated civil works.

The indicative list of structures and buildings are mentioned below but not limited to the same.

1. Mobilization of slip form materials.
2. Assembly & Erecting in position the slipform including and operation of Slipform during shell concreting including providing winches, passenger elevators, etc.
3. Bar bending & binding and shuttering works (Reinforcement steel - free supply by BHEL)
4. Supply & Pouring the concrete (Cement - free supply by BHEL)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

5. Shell concreting including provision for openings, pockets and inserts in the chimney shell
6. External Platform of Chimney
7. Chimney concrete roof including kerbs
8. Painting Works
9. - Void -
10. Fabrication works of flue can, internal platforms, staircase, etc. with the steel materials provided by BHEL including surface finish and painting.
11. Expansion joints between flue cans
12. Erecting the flue cans & platforms in position including providing winches, temporary passenger elevators, etc. (Structural steel free supply by BHEL)
13. Supply, fabrication and erection of gratings
14. Fabrication and erection of Chequered plates (Chequered plate free supply by BHEL)
15. Supply and erection of Rolling shutters
16. Application of borosilicate glass blocks (BHEL shall supply Borosilicate glass block lining materials & QA supervision free of cost)
17. Condensate collection system.
18. Design of Chimney Electrical works including chimney lighting (illumination), earthing and lightning protection systems along with Supply of all electrical items, Erection, testing and commissioning of all electrical systems for chimney as per Technical Specification.
19. Supply of Mandatory Spares and Special tools and tackles for Chimney Electrical works as per Technical Specification.
20. Elevator supply & Installation works incl. supply of Mandatory Spares and Special tools and tackles required for Maintenance of the Elevator as per Technical Specification.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Note: Any other building / structure / foundation not mentioned above, but required for completion of the package in total, deemed to have been included in the bidder scope under this contract. Such work will be executed under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC. Cement & Reinforcement steel for civil works, MS round for below ground earthing and Structural steel for structural works and borosilicate glass blocks for lining system shall be provided by BHEL free of cost only for incorporation in the permanent work of the subject tender.

Note: Structural required for embedments/ inserts will not be provided by BHEL.

- 1.2.2 The works to be performed under this contract consist of providing all labour, supervision, material, scaffolding, construction equipment's, tools and plants, temporary works, supplies including POL (fuel, oil & lubricant), transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects.
- 1.2.3 Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, preparation of fabrication drawings etc. are included on the rates of items of work. Works shall only be carried out with approved structural fabrication drawings.
- 1.2.4 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be burnt or otherwise disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.
- 1.2.5 All the works areas shall be adequately flood lighted to the satisfaction of the Engineer-in-Charge when the work is in progress during the night shifts.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.2.6 The unit rates shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.
- 1.2.7 The unit rates for various items shall include all the stipulations mentioned in technical specifications for the particular B.O.Q item and nothing extra over B.O.Q rates shall be payable.
- 1.2.8 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.
- 1.2.9 The bidder should fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, local conditions, soil strata and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may have not been specifically brought out in the specifications.
- 1.2.10 Special arrangements to be made for tackling pandemic – Contractor shall make arrangements for stay of workers within their premises as far as possible and/ or adjacent building and for implementation of STANDARD OPERATING PROTOCOL (SOP) as per government order. The transportation of workers to work place shall be arranged by the contractor in dedicated transport by ensuring social distance. Any person violating the pandemic measures published vide government order time to time will be liable to be proceeded for legal action as per the government order. Following shall be observed in work place:
- 1.2.11 All work places shall have adequate arrangements for temperature screening and provide sanitizers at convenient places.
- 1.2.12 Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
- 1.2.13 Use of AROGYA SETU will be encouraged for all employees both private and public.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.2.14 Contractor shall sanitize their work place between shifts.
- 1.2.15 Large meetings to be prohibited. Spitting shall be strictly prohibited. Wearing of face cover is compulsory.
- 1.2.16 Government order (state/ center) being issued time to time for protective measures of pandemic shall be complied with strictly until government (state/ center) declares end of pandemic.
- 1.2.17 **Standard operating procedure for social distancing for workplace and offices**

The following measures shall be implemented by contractor for their office and workplaces:

1. All areas in the work premises including the following shall be disinfected completely using user friendly disinfectant mediums
2. Entrance gate of work place, office, if any
3. Cafeteria and canteens, if any
4. Meeting room, conference halls/ open area available/ verandah/ entrance gate of site, bunkers, porta cabins, buildings, etc.
5. Equipments and lifts
6. Washroom, toilet, sink, water points, etc.
7. Wall/ all other surfaces
8. For workers coming from outside, special transportation facility shall be arranged without any dependency on the public transport system. These vehicles should be allowed to work only with 30-40% passenger capacity.
9. All vehicles and machinery entering the premise should be disinfected by spray mandatorily.
10. Mandatory thermal scanning of everyone entering and exiting the work place to be done.
11. Medical insurance for the workers to be made mandatory.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

12. Provision for hand wash & sanitizer preferably with touch free mechanism shall be made at all entry and exit points and common areas. Sufficient quantities of all the items should be available.
13. Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
14. Large gatherings or meetings of 10 or more people to discouraged. Seating at least 6 feet away from others on job sites and in gatherings, meetings and training sessions.
15. Not more than 2/4 persons (depending on size) will be allowed to travel in lifts or hoists.
16. Use of staircase for climbing should be encourages.
17. There should be strict ban of gutka, tobacco, etc. and spitting should be strictly prohibited.
18. There should be total ban on non-essential visitors at sites.
19. Hospitals/ clinics in the nearby areas, which are authorized to treat pandemic patients, should be identified and list should be available at work place all the times.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART – I CHAPTER – III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR/ BHEL

1.3 FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR/ BHEL

1.3.1 PART I - (SCOPE MATRIX)

SL.NO	DESCRIPTION - PART I	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
1.3.1.1	ESTABLISHMENT			
1.3.1.1.1	For Construction Purpose:			
A	Open space for office	Yes		Free of charges as provided by NTPL
B	Open space for storage	Yes		Free of charges as provided by NTPL
C	Construction of bidder's office, canteen and storage building, cement storage shed including supply of materials and other services		Yes	At bidder's own cost
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	At bidder's own cost
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	At bidder's own cost
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	At bidder's own cost
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	At bidder's own cost

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SL.NO	DESCRIPTION - PART I	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
1.3.1.1.2	For Living Purposes of the Successful Bidder's Personnel			
A	Open space	Yes		As provided by NTPL on chargeable basis as per the prevailing rate of NTPL
B	Living accommodation		Yes	At bidder's own cost
1.3.1.2	ELECTRICITY			
1.3.1.2.1	Electricity For construction purposes	Yes		Free of Charges as provided by M/s NTPL
1.3.1.2.1.1	Single point source (In general) For detail, refer clause no. 1.3.5.1	Yes		As provided by M/s NTPL
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	At bidder's own cost
1.3.1.2.2	Electricity for the office, stores, canteen, labour colony, etc. of the bidder which include:	Yes		As provided by NTPL on chargeable basis as per the prevailing rate of NTPL
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	At bidder's own cost

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SL.NO	DESCRIPTION - PART I	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	At bidder's own cost
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	At bidder's own cost
1.3.1.2.2.4	Demobilization of the facilities after completion of works		Yes	At bidder's own cost
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc. on the above lines. (in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	At bidder's own cost
1.3.1.3	WATER SUPPLY			
1.3.1.3.1	For construction purposes:	Yes		Free of charge as provided by M/s NTPL
1.3.1.3.1.1	Making the water available at single point	Yes		As provided by M/s NTPL
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
1.3.1.3.2	Water supply for bidder's office, stores, canteen, labour colony, etc.	Yes		At single point, Free of charge as provided by M/s NTPL
1.3.1.3.2.1	Making the water available at single point	Yes		As provided by M/s NTPL

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SL.NO	DESCRIPTION - PART I	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
1.3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
1.3.1.4	LIGHTING			
1.3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area At the construction site / area		Yes	At bidder's own cost
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) At office storage area At the preassembly area At the construction site /area At the labour hutment		Yes	At bidder's own cost
1.3.1.5	COMMUNICATION FACILITIES FOR SITE OPERATIONS OF THE BIDDER			
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc.		Yes	At bidder's own cost

1.3.2 PART II - (SCOPE MATRIX)

SL.NO	DESCRIPTION - PART II	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
	CONSTRUCTION FACILITIES			

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SL.NO	DESCRIPTION - PART II	SCOPE TO BE TAKEN CARE BY		REMARKS
		BHEL	BIDDER	
1.3.2.1	ENGINEERING WORKS FOR CONSTRUCTION			
1.3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		Progressively
1.3.2.1.2	Detailing of drawings for construction		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	"
1.3.2.1.4	Shipping lists etc. for reference and planning the activities	Yes	Yes	"
1.3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL, As per requirement of BHEL targets
1.3.2.1.6	Review of performance (Form-14) and revision of site construction schedules in order to achieve the end dates and other commitments		Yes	
1.3.2.1.7	Weekly construction schedules based on SI No 1.3.2.1.5		Yes	
1.3.2.1.8	Daily construction / work plan based on SI No 1.3. 2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	At bidder's own cost

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.3.3 OPEN SPACE:

Open space for Site Office, Stores and for site fabrication on “as is where is basis” as provided by NTPL will be provided to bidder free of cost. Availability of land within plant boundary is very limited and the contractor has to plan and use the existing land considering the use of land by other contractors and the storage of plant machineries and materials. The existing land shall be shared by all contract agencies. Land will be allocated with certain time frame and to the extent available/ considered necessary, and will be reviewed by BHEL depending upon the area availability. Area within plant premises for fabrication, batching plant, office, storage area etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all the lands (as received from BHEL during various stages of construction) after completion of tendered work.

1.3.4 LABOUR COLONY

1.3.4.1 Land for labour colony will be allotted by BHEL as provided by NTPL on nominal rent as follows.

- i. Nominal rent will be charged, all Facilities for labor colony shall be the sole responsibility of the Contractor. Presently, the rent for land of labour colony is charged at a rate of Rs. 2.17 per sq.m., per month plus applicable GST as indicated by NTPL. However, this is subject to revision by NTPL and will be informed to successful bidder. The approximate distance of the land from site is 4 Km. Contractor to bear the above rent and no additional payment shall be made by BHEL on account of increase of rent.
- ii. After completion of the work, land shall be handed over as per terms of conditions indicated in this clause below.
- iii. The allotment shall remain valid till the period of contract and shall automatically cease after expiry of the period of the contract. The validity

TECHNICAL CONDITIONS OF CONTRACT (TCC)

shall also automatically cease on termination of contract due to any reason whatsoever.

- iv. The Contractor may build only temporary structures on the land allotted to him.
- v. The land shall not be used for any purpose other than the purpose for which it is allotted.
- vi. The allotment is made purely for the present work and is not transferable in any manner either in whole or in part nor can it be utilized for the purpose of any other contract.
- vii. On completion of the work, the Contractor shall remove all temporary structures built by him and restore the land to its original condition.
- viii. After the completion of the works and on expiry of the contract period or on termination of contract, the Contractor shall give vacant possession of the land.
- ix. If the Contractor fails to give vacant possession of the land as aforesaid in its original condition, the Purchaser reserves the right to withhold payment of Contractor's bills till handing over of the vacant possession of the land. Besides, the Contractor shall be liable to pay compensation for such unauthorized occupation of land.
- x. The Purchaser shall determine the amount of compensation to be paid by the Contractor in this respect and such determination shall be final and binding on the contractor. The amount of compensation shall be realized from the Contractor forthwith and/or adjusted without any notice from the bills of the Contractor and/or from dues payable by the Purchaser to the Contractor.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.3.4.2 The Contractor shall be provided with power on chargeable basis at actual as charged by TNEB at one place only as decided by the NTPL in the labor colony.

Further distribution is to be done by the contractor at his own cost.

1.3.4.3 Free water supply at one point in the labour colony shall be provided by the NTPL.

Further distribution is to be done by the contractor at his own cost.

1.3.4.4 Drinking water shall be provided at a single point near the colony by the NTPL.

1.3.4.5 The contractor to construct labour colony/ hutment at his own cost.

1.3.4.6 The Contractor shall, at its own expense, make adequate arrangements for housing, road and provision for washing/ bathing along with required toilets for its staff and labor, drainage system for disposal of sewerage and sullage and for temporary creche (balmandir) where 50 or more women are employed at a time at his own cost.

1.3.4.7 Suitable paved area to be provided in the labour colony at his own cost.

1.3.5 **ELECTRICITY:**

1.3.5.1 In general, construction power will be provided to the contractor free of cost at one single point within the plant area by BHEL as provided by NTPL. The contractor has to provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc. However, based on request of contractor and requirement of project, BHEL site in charge, at his discretion, may provide construction power at multiple point (as close to work area as possible), free of cost, for smooth execution of the work at site. If, BHEL provides electricity at more than one point (as close to work area as possible), it will be responsibility of the contractor to provide all the support necessary for enabling BHEL for extending such provision to contractor. The contractor has to provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.3.5.2 All temporary wiring must comply with local regulations and relevant Indian electrical act and will be subject to the BHEL/NTPL's inspection and approval before connection to supply and later.
- 1.3.5.3 Necessary "Capacitor Banks" to improve the Power factor to a minimum of 0.9 shall be provided by the contractor at his cost. Penalty if any levied by customer on this account will be recovered from contractor's bills.
- 1.3.5.4 Any duty, deposit involved in getting the Electricity shall be borne by the bidder.
- 1.3.5.5 Contractor has to make their own arrangements for distribution of electricity as per requirement for office shed, canteen, storage sheds at their cost.
- 1.3.5.6 Provision for distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cables and cable laying including supply of all materials like cables, wires, switches, switch boards, pipes etc., observing the safety rules laid down by electrical authority of the State/ BHEL/ their customer with appropriate statutory requirements shall be the responsibility of the tenderer/ contractor.
- 1.3.5.7 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.
- 1.3.5.8 As there are bound to be interruptions in regular power supply, power cut/ load shedding in any construction sites, contractor should make his own arrangement for alternative source of power supply through deployment of adequate number of DG sets at their cost during the power breakdown / failure to get urgent and important work to go on without interruptions. No separate payment shall be made for this contingency.
- 1.3.6 **WATER:**
- 1.3.6.1 Water (Raw water) required for construction purposes will be provided at one single point within the plant area free of cost. The required pumps & accessories, pipes

TECHNICAL CONDITIONS OF CONTRACT (TCC)

for drawing water from the given point and further distribution will be arranged by the contractor at their cost to go on without interruptions.

1.3.6.2 In case of non-availability of water, the contractor shall make his own arrangements of **water suitable for construction purpose** to have uninterrupted work. No separate payment shall be made for any contingency arrangement made by contractor, due to delay / failure for providing water supply.

1.3.7 MATERIAL SUPPLY:

Supply/ providing coarse aggregate, fine aggregate (river sand only) and all other materials required (except free supply materials i.e. cement, reinforcement steel, structural steel for structural works, structural steel for embedments/inserts from scraps (if available), foundation bolts & insert/ embedments (as applicable) supplied by manufacturing unit(s) of BHEL) for the work are in the scope of the contractor. **BHEL shall provide Cement, reinforcement steel for civil works, structural steel for fabrication works and borosilicate glass blocks only for incorporation in the permanent work AS FREE SUPPLY. (Note: Structural required for embedments/ inserts will not be provided by BHEL.)** Supply of stainless steel, non-metallic expansion compensator, electrical items, etc. are in the scope of bidder.

1.3.7.1 CEMENT

Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (minimum 2 numbers of 100 MT each for storing capacity minimum of 200MT per 30 Cum/hr batching plant) to be installed by the bidder nearer to their batching plants. Making arrangement for unloading of cement into the silo and provision of necessary manpower support is in the scope of successful bidder within the quoted price. On advance request of the bidder, the cement shall be supplied in Bags for other than RCC works like masonry, flooring works etc. Advance request for supply of cement in bags for

TECHNICAL CONDITIONS OF CONTRACT (TCC)

these works shall be minimum two months. Cement shall be supplied in bags for carrying out design mix for the package. Advance request for supply of cement in bags required for design mix shall be minimum one month. Provision of necessary storage. Arrangement for cement received in bags is in the scope of successful bidder within the quoted price.

1.3.7.2 **STEEL**

The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths. In some instances, for 8mm, 10mm & 12mm dia reinforcement steel will be supplied in coil form. No extra claims will be entertained against issue of Non-standard lengths of steel and de coiling of 8mm, 10mm & 12mm dia. steel.

If any matching sections of steel are not available with BHEL, contractor may arrange these sections from Customer approved agencies only on certification of BHEL and the same shall be paid against relevant BOQ item in the price bid.

1.3.7.3 **SUPPLY OF BOROSILICATE GLASS BLOCKS**

1.3.7.3.1 Borosilicate glass blocks will be supplied by BHEL free of cost. However, handling of Borosilicate Glass blocks procured by BHEL for this tender scope, at site, including transportation from Stores to erection area will be in the scope of contractor. No Extra payment shall be made for this work.

1.3.7.3.2 BHEL shall supply borosilicate glass block lining system, including closed cell borosilicate glass blocks, adhesive membrane and compatible primer. BHEL shall also arrange for onsite QA supervision/ expert supervision by borosilicate glass manufacturer during installation of borosilicate glass blocks by the Bidder in the steel flue can, SS minishell as applicable and flue gas duct upto Chimney inlet flange (incl. transition duct) as per Specifications.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.3.7.3.3 Unloading, Handling, storage, transportation within site premises and application of the borosilicate glass block lining materials is in scope of bidder.
- 1.3.7.3.4 All materials pertaining to borosilicate glass block lining system shall be stored in a covered dry area and within the temperature and humidity limits, as recommended by the supplier. Do not allow to exceed shelf-life limits, as determined by the supplier. Information regarding expiry of shelf life to be informed to BHEL in advance. The bidder shall comply the supplier specification/ requirements for handling, transit and storage.
- 1.3.7.3.5 Bidder is responsible for unloading the borosilicate lining material as soon as the arrival of material, in the weather proof closed storage /air conditioned storage sheds/ container (as per supplier specification). The construction of adequate and suitable storage sheds as per the requirement of BHEL & supplier, unloading of borosilicate lining material, stacking properly in the storage sheds, removal of the sheds after the completion of the work is in the scope of bidder.
- 1.3.7.3.6 The borosilicate glass blocks shall be of thickness 51 mm. A nominal adhesive thickness of 3.2 mm is recommended behind and between each block. A 1.6-mm thick layer should be troweled onto the liner, as well as to the sides and back of each brick, before installation. This double-buttering technique ensures a full bond of each block to the liner and to each other. Excess adhesive material squeezed out during placement of the block should be struck clean.
- 1.3.7.3.7 Installation of blocks shall be carried out as per specification, drawings, direction of engineer in charge, in expert supervision by borosilicate glass manufacturer and accepted by the customer. Contractor shall prepare the installation procedure taking into consideration the requirements of

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Borosilicate glass block manufacturer/ supplier and get the same approved by NTPL & BHEL before installation including verification of installation procedure & workmanship standards of the lining system.

- 1.3.7.3.8 The steel surface shall be grit blasted to a cleanliness of SA 2 1/2 and approved by the supplier of the lining system. The substrate shall thereafter be primed using a high performance epoxy primer within a short time window approved by the supplier. The application of suitable primer as per manufacturer specification, application of adhesive membrane and installation of borosilicate glass block at any height on ground or over erected position in flue can including cost of skilled labour, material, tools & tackles, equipment etc. all complete required to complete the job at any height in the scope of the bidder.
- 1.3.7.3.9 Installation of borosilicate glass block lining shall be performed strictly under supervision of Borosilicate Glass Block supplier's representative. Supervisory person of borosilicate glass block supplier shall be arranged by BHEL. However, in addition to the above, continuous supervision by the bidder's engineer is very essential at all stages of installation of borosilicate glass blocks.
- 1.3.7.3.10 The bidder shall follow the instruction & guidance of the Borosilicate Glass Block supplier from the time the material is issued to the Contractor, during handling, transportation till completion of installation of Borosilicate Glass Block & handing over of the flue can with borosilicate lining system in order to minimize damage to borosilicate glass blocks and other lining materials.
- 1.3.7.3.11 The quoted rate is for installation of blocks at ground level or at any height or over erected position including skilled labour, material, T&P, equipments, etc. All complete required to complete the job at any height.

1.3.7.4 CONSUMABLES

TECHNICAL CONDITIONS OF CONTRACT (TCC)

All consumables, like gas, electrodes, chemicals, lubricants etc. required for the scope of work, shall be arranged by the contractor at his cost unless otherwise specifically mentioned in the contract.

In the event of failure of contractor to bring necessary and sufficient consumables, BHEL may arrange for the same at the risk and cost of the contractor. The entire cost towards this along-with overhead shall be paid by the contractor or deducted from the contractor's bills.

1.3.8 **LIGHTING FACILITY:**

Adequate lighting facilities such as flood lamps, hand lamps and area lighting shall be arranged by the contractor at the site of construction, and contractor's material storage area etc. at his cost.

1.3.9 **CONTRACTOR'S OBLIGATION ON COMPLETION:**

On completion of work, all the temporary buildings, structures, pipe lines, cables etc. shall be dismantled and leveled and debris shall be removed as per instructions of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.3.10 **DEWATERING**

Contractor shall ensure at all times that his work area & approach/ access roads are free from accumulation of water, so that the materials are safe and the erection/ progress schedule are not affected. No separate claim in this regard shall be admitted by BHEL. No separate payments for dewatering of subsoil, surface water or catchments water, if required, at any time during execution of the work including monsoon period shall be considered by BHEL.

Situation of flood shall be dealt separately and situation of flood shall be accounted upon certification of engineer in-charge or as per announcement of local Administrative body.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

For discharge of Sub-soil water / rain water, a suitable piping system with pumping arrangement should be provided by the contractor with prior approval of owner to the nearby sump/drain i.e. Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

1.3.11 **BID DRAWINGS**

Bid drawings enclosed for information and this may get revised during execution.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART – I CHAPTER – IV

T&PS TO BE DEPLOYED BY CONTRACTOR

1.4 T&PS TO BE DEPLOYED BY CONTRACTOR

- 1.4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.
- 1.4.2 The contractor is required to arrange the following tentative Major T&Ps per package and other T&Ps for the satisfactory completion of the work.

S. NO	T&P ITEMS	MOBILIZING TIME FROM THE DATE OF START OF WORK
A	Major T&P items	
1.	1 no. automatic concrete batching plant with printing facility (minimum 30 cum/hr capacity) with 2 numbers of cement silos of each 100 MT storing capacity for cumulative storage capacity minimum 200MT cement) with DG back up.	Within 30 days or as mutually agreed between bidder and BHEL Engineer In-Charge at site as per the requirement of work.
2.	1 no. concrete pump (60 cum/hr) capacity and lift up to 70 metres or 1 no. truck mounted concrete mixer cum pump along with placing boom minimum 36m high i.e. concrete boom placer.	As per BHEL site requirement.
3.	Complete hydraulic slip form assembly with jacks and climbing rods of adequate nos including 2 nos of power pack with hanging platform inside and outside, safety ropes, MS shutters , required scaffolding materials, etc.	As per BHEL site requirement.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S. NO	T&P ITEMS	MOBILIZING TIME FROM THE DATE OF START OF WORK
4.	Passenger lift cabin along with power winch for carrying min 6 person with safety block (safety devices).	As per BHEL site requirement.
5.	Minimum 3MT capacity power winch for lifting concrete – 3 nos including 1 nos stand-by.	As per BHEL site requirement.
6.	Minimum 3MT capacity power winch for lifting reinforcement - 2nos.	As per BHEL site requirement.
7.	20 MT capacity winch for girder beam lifting – 2nos.	As per BHEL site requirement.
8.	Transit mixers (5/6 cum) – 3 nos including 1 nos standby.	As per BHEL site requirement.
B	Other T&P items	
9.	2 nos. multistage high lift water pump (for curing, lifting height 200 metres). One shall be working type and other shall be stand by.	Before start of chimney shell.
10.	Shot Blasting Equipment	As per BHEL site requirement.
11.	Welding rectifier (400 Amps to 600 Amps) – 10 nos.	As per BHEL site requirement.
12.	1nos- 40MT tyre/ crawler mounted crane and 2 nos pick & carry crane of minimum 9 tonne capacity.	As per BHEL site requirement.
13.	2 sets of strand jacks of required capacity (includes 2 nos standby jacks) with 2 nos power pack including strand rope of adequate thickness & length.	As per BHEL site requirement.
14.	1 no. motorized MS plate bending machine (width capable of bending one standard width of the plate) along with angle bending device.	As per BHEL site requirement.
15.	Power winch – 2.5 T- 2 nos. for internal/ external finishing with	As per BHEL site requirement.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S. NO	T&P ITEMS	MOBILIZING TIME FROM THE DATE OF START OF WORK
	adequate capacity of suspended platform.	
16.	Walky Talky – 6 nos.	As per BHEL site requirement.
17.	Plate compactor.	As per BHEL site requirement.
18.	Civil laboratory equipment's as per list in Clause No. 1.4.6 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 45 days or as mutually agreed between bidder and BHEL Engineer In-Charge at site as per the requirement of work.
19.	60 nos. concrete cube moulds	Within 15 days.
20.	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per BHEL site requirement.
21.	Construction power cable (1000 RM).	As per BHEL site requirement.
22.	Construction water Pipeline 3000 RM(100/75/32/25 dia. GI Pipe).	As per BHEL site requirement.
23.	10 nos. Concrete vibrator with adequate needle (Minimum 10 nos. diesel driven)	As per BHEL site requirement.
24.	Portable fire extinguishers as below: Soda acid – 40 sets. Dry chemical powder – 40 sets CO2 – 25 sets. Water & sand bucket (4 buckets in one stand) – 20 sets. Fire hose with nozzle (50 M length) – 8 sets.	As per BHEL site requirement.
25.	1 Nos. Radial drill machine	As per BHEL site requirement.
26.	1 nos. magnetic base drill machine	As per BHEL site requirement.
27.	2 nos. submerged arch welding machine	As per BHEL site requirement.
28.	2 nos. MIG machine	As per BHEL site requirement.
29.	1 no. trailor – 15T	As per BHEL site requirement.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S. NO	T&P ITEMS	MOBILIZING TIME FROM THE DATE OF START OF WORK
30.	1 no. power driven HSFG bolt tightening m/c	As per BHEL site requirement.
31.	1 no. torque tightening m/c. (Capacity up to 30 dia HSFG bolt tightening)	As per BHEL site requirement.
32.	Sufficient quantity of steel ladders for approach up to the top of each erected column to be required during erection of columns.	As per BHEL site requirement.
33.	1 no ultra-sonography testing machine with printing/ recording facility for structural work.	As per BHEL site requirement.
34.	1 no. Painting equipment sets complete with required compressor, hopper, screen, blasting hose pipe, nozzle airless/conventional spray (within CGI temporary cover shed)	As per BHEL site requirement.
35.	Ropes/ slings including D-shackles	As per BHEL site requirement.
36.	Grinding & Buffing machines	As per BHEL site requirement.
37.	Steel jolly for temporary working platforms	As per BHEL site requirement.
38.	1 no. drinking water tank – 5000 lit.	Within 30 days or as mutually agreed between bidder and BHEL Engineer In-Charge at site as per the requirement of work.
39.	2 no. mobile toilet blocks for labour use.	2 nos. within 30 days or as mutually agreed between bidder and BHEL Engineer In-Charge at site as per the requirement of work

Note:

1. T&P shown in the above mentioned list is tentative requirement considering parallel working in all areas mentioned in the scope of work. However, mobilization schedule and quantity/ numbers as mutually agreed at site for major T&Ps & other T&Ps, have to be adhered to. Numbers/ time of requirement of T&Ps will be reviewed time to time by BHEL site and contractor will provide required T&P/ equipment's to ensure completion of entire

TECHNICAL CONDITIONS OF CONTRACT (TCC)

work within schedule/ target date of completion without any additional financial implication to BHEL. Vendor will give advance intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.

2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.

3. In the event of contractor failing to arrange the required tools, plants, machineries, equipment, material or non-availability of the same owing to breakdown, BHEL will make alternative arrangement at the risk and cost of the contractor.

Case 1: BHEL provides its own Capital T&P.

In case the BHEL provides any T&P which is owned by BHEL, hire charges (as per BHEL norms) will be recovered from the contractor as per the prevailing BHEL corporate hire charges. In case, the T&P is specifically listed in "T&Ps to be deployed by Contractor", "Hire charges applicable to outside agencies other than contractors working for BHEL" will apply. If not listed, "hire charges applicable to contractor working for BHEL" will apply. The hire charges of Capital tools & plants are exclusive of operating expenses e.g. operator, fuel & consumables and the same shall be arranged by the contractor at his cost.

Case 2: In all cases other than that specified in case 1 above, actual expenses incurred by BHEL along with applicable overheads will be back-charges to the contractor.

4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.

5. Clause No. 1.6.1. of this specification (i.e. TCC) may please be referred for date of commencement of work.

6. Mobilization of concrete boom placer in place of concrete pump will be allowed based on site requirement of BHEL.

7. Crane of upto SWL 150MT is in the scope of bidder and shall be brought to site/ arranged in site as per requirement for erection of steel structures at site (As and when required).

1.4.3 In addition to the above, any other tools and plants required for execution of the above work are in contractor's scope.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.4.4 The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing.
- 1.4.5 The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.
- 1.4.6 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment's like as given in table below:

S NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
	CONCRETE TESTING EQUIPMENT			
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513
2	Shrinkage of cement, Auto Clave Test	Le Chatelier's apparatus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angeles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact testing machine with blow counter	Standard	IS 9377
5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation gauge	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5, 10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorised vibration machine for cement testing	Standard	IS 4031
12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383
13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75 mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	IS 383
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	
	SOIL TESTING EQUIPMENT			
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

TECHNICAL CONDITIONS OF CONTRACT (TCC)

List of testing equipment mentioned in the table above is tentative and final requirement shall be as mutually agreed between successful bidder and BHEL Engineer In-Charge in compliance with requirement spelt in FQP (Field quality plan).

- 1.4.7 Contractor shall have at all times experienced operators and technicians for routine and breakdown maintenance of the equipment. Any delay in rectification of defects will warrant BHEL rectifying the defect and charging the cost to the contractor.
- 1.4.8 The area and infrastructure development of the work area are to be carried out by the customer. However, in construction projects of this magnitude it is possible that all the areas/ approaches may not be ready. In such cases consolidation of ground and arrangement of sleepers/ sand bag filling etc. for safe operation/ movement of equipment including cranes/ trailers etc. shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.
- 1.4.9 In general, any crane for the tendered scope will not be provided by BHEL. However, if requirement of crane of higher capacity arises for any unforeseen circumstance (i.e. more than 150MT), bidder may request BHEL to provide crane on chargeable basis but BHEL reserves right of provision of crane. If provided, in that case, Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.
- 1.4.10 Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes. The age of the contractor deployed cranes upto 150 T should be within 15 years as on date of deployment. Contractor has to provide documentary proof for the age of the crane at the time of deployment to the BHEL Engineer.
- 1.4.11 In case, cement is issued through bulkers being supplied from manufacturer /stockiest, the same shall be emptied in cement silos of batching plant and

TECHNICAL CONDITIONS OF CONTRACT (TCC)

necessary assistance shall be provided by contractor. Contractor to note that batching plant being established at site shall have adequate number of cement silos of cumulative capacity 200 MT as mentioned in Clause No. 1.4.2.- list of Tools & Plants to be deployed by the contractor.

VOLUME-IA PART – I CHAPTER – V

T&Ps PROVIDED BY BHEL

1.5 T&PS PROVIDED BY BHEL

- 1.5.1 BHEL will not provide any T & Ps for the tendered work. However, if in any unforeseen circumstances, requirement of any T&Ps (available with BHEL at site) arises, on request of bidder the same may be provided on chargeable basis but BHEL reserves the right of provision of such T&Ps. Charges shall be applied as per BHEL norms and guidelines and direction of engineer in-charge.

VOLUME-IA PART – I CHAPTER-VI

TIME SCHEDULE

1.6 TIME SCHEDULE

1.6.1 COMMENCEMENT OF WORK

1.6.1.1 The commencement of work at site shall be mutually agreed date between bidder and BHEL to start the work. Foundation of RCC chimney shall be handed over to contractor by BHEL.

1.6.1.2 The entire work of construction of twin flue RCC chimney (excluding foundation work) as detailed in the Tender Specification shall be completed within **13 (Thirteen) months** from the date of commencement of work with intermediate milestone as detailed below.

1.6.1.2.1 Completion of RCC works of chimney shell – 6 months

1.6.1.2.2 Completion of Application of borosilicate glass block lining – 11 months

1.6.1.3 During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.

1.6.1.4 The contractor is required to refer Form 15 in Volume 1- Book 2 for all the instructions to be taken immediately after receipt of LOI.

1.6.2 MOBILISATION

1.6.2.1 The Contractor has to augment his resources in such a manner to achieve the Completion Schedules.

1.6.2.2 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the tenderer taking into consideration of the Completion Schedules/ site decision on drawings flow (latest) and submitted for BHEL's approval.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.6.2.3 In order to meet above schedule in general, and any other intermediate targets set, to meet customer/ project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

1.6.2.4 In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.3 **SUBMISSION OF L3 SCHEDULE**

The contractor shall submit a detailed area/ structure wise L3 schedule within 15 days from date of issue of LOI, in consultation with BHEL based on the tentative schedule provided as per the Clause No. 1.6.5. The major activities as mentioned against the work schedule given in Clause No.1.6.5 are to be indicated in detailed schedule which will be prepared by the bidder. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects (or any suitable format as agreed between contractor and BHEL engineer in-charge) to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, fabrication & erection activities, etc. This schedule shall also clearly indicate the interface facilities/inputs to be provided by BHEL/Customer and the dates by which such facilities/inputs are required. The schedule shall be acceptable to BHEL for meeting their mile stone targets/schedule.

1.6.4 **GUARANTEE PERIOD**

Guarantee period of 12 months shall commence from the date of completion of the whole work certified by the BHEL Engineer.

1.6.5 **SCHEDULE**

1.6.5.1 The schedule for chimney works is as given below.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S NO.	SYSTEM DESCRIPTION	COMPLETION FROM THE DATE OF COMMENCEMENT OF CIVIL WORK
1.	Completion of RCC works of chimney shell	Progressively upto 6 th month
2.	Fabrication & Erection of roof beams & intermediate floor beams	Progressively upto 7 th month
3.	Fabrication of flue cans	Progressively by 6 th month
4.	Roof slab completion	Progressively by 7 th month
5.	External platforms	Progressively by 9 th month
6.	Erection of flue can	Progressively by 9 th month
7.	Application of borosilicate glass block lining	Progressively by 11 th month
8.	Electrical works	Progressively by 12 th month
9.	Elevator erection & commissioning	Progressively by 12 th month
10.	Painting & finishing works and all balance miscellaneous work & handing over	Progressively by 12 th month
11.	Submission of final bill & reconciliation of steel & cement	Progressively by 13 th month

1.6.5.2 The above schedule is tentative. The above completion schedule of chimney is for entire completion and handing over the chimney to BHEL. The foundations, pedestals, floors, and any structure, required for the start of mechanical equipment erection/ commissioning work (as applicable), shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

1.6.6 PENALTY FOR INTERMEDIATE MILESTONES

S NO	DESCRIPTION	COMPLETION MONTH FROM THE CONTRACTUAL DATE OF START OF THE WORK	INTERMEDIATE MILESTONE
1	Completion of RCC works of chimney shell	6 th Month	M1
2	Application of borosilicate glass block lining	11 th month	M2

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.6.6.1 M1 and M2 shall be intermediate milestones for this work. In case delay in achieving M1 milestone the penalty shall be levied on the bidder. In case delay in achieving each M1 milestone is solely attributable to the contractor, 0.5% per week of executable contract value limited to maximum 2% of executable contract value will be withheld. In case delay in achieving each M2 milestone is solely attributable to the contractor, 0.5% per week of executable contract value** limited to maximum 3.0% of executable contract value will be withheld.
- 1.6.6.2 Amount already withheld, if any, against slippage of M1 milestone, shall be released only if there is no delay attributable to contractor in achievement of M2 milestone.
- 1.6.6.3 Amount required to be withheld on account of slippage of identified intermediate milestone shall be withheld out of respective milestone payment and balance amount shall be withheld at 10% of RA bill amount from subsequent RA bills.
- 1.6.6.4 Final deduction towards LD (if applicable) on account of delay attributable to contractor shall be based on final delay analysis on completion/ closure of contract as per GCC. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.
- 1.6.6.5 In case of termination of contract due to any reason attributable to contractor before completion of work, the amount already withheld against slippage of intermediate milestones shall not be released and be converted into recovery.
- Note: **executable contract value - value of work for which inputs/ fronts were made available to contractor and were scheduled for execution till the date of achievement of that milestone.

1.6.7 RECORDS TO BE MAINTAINED AT SITE

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.6.7.1 Record of Quantity of Free/Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.
- 1.6.7.2 The under mentioned Records/ Log-books/ Registers applicable to be maintained.
- 1.6.7.3 Hindrance Register.
- 1.6.7.4 Site Order Book.
- 1.6.7.5 Test Check of measurements.
- 1.6.7.6 Cement Supply and Consumption Daily Register
- 1.6.7.7 Records of Test reports of Field tests.
- 1.6.7.8 Records of manufacture's test certificates.
- 1.6.7.9 Records of disposal of scraps generated during and after the work completion.

VOLUME-IA PART-I CHAPTER-VII

TERMS OF PAYMENT

1.7 TERMS OF PAYMENT

1.7.1 SECURED ADVANCE

Not applicable

1.7.2 ADVANCE FOR MOBILIZATION

1.7.2.1 Interest bearing advance for Mobilization, limited to 5% of the contract value will be paid against submission of bank guarantee of at least 110% of the advance valid for the contract period, which will be recovered from the first running bill onwards. The advance for mobilization shall be paid as under.

1.7.2.1.1 2% of contract value after receipt of initial Security Deposit, as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.

1.7.2.1.2 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below (provided Clause No. 1.7.2.1.1 has been complied with) and on certification by site in-charge for compliance.

a) Batching plant of specified capacity & number as per Clause No. 1.4.2

b) Transit mixer of 5/6 cum capacity – 2 nos

c) Concrete pump (60 cum/ hr) – 1 nos

1.7.2.1.3 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below in addition to the above, and on certification by site in-charge for compliance.

1. Motorized Plate bending machine for MS plates– 1 nos

2. Transit mixer of 5/6 cum capacity – 1 No

3. Power winch of capacity minimum 3MT - 2 nos.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4. Strand jack system with all required assembly – 2 nos
5. Civil Laboratory – 1 No.

Note: Mobilization of concrete boom placer (of adequate capacity as required in site and approved by Engineer In-Charge) in place of concrete pump will be allowed based on site requirement of BHEL.

- 1.7.3 Payment of advance as specified herein and recovery of the advance will be as per Clause No. 2.13 of GCC. Option of availing the interest bearing mobilization advance is left with the bidder.

1.7.4 INTERIM PAYMENT

- 1.7.4.1 Interim bills in the form of monthly running bills prepared by the contractor in soft as well as Hard copies shall be based on the quantities executed and measured.

- 1.7.4.2 95% item rate shall be released after completion of works certification by Engineer in charge.

- 1.7.4.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.

- 1.7.4.4 Retention amount shall be as per GCC.

- 1.7.5 BHEL Site Engineer, at discretion, may operate the part rate of the items in line with GCC clause no. 2.23.1 (v). Payment for supply portion (subjected to approval of Engineer In-Charge) shall be made only after receipt of material at site.

1.7.6 ROYALTY/ SEIGNIORAGE CHARGES

Royalty/ seigniorage charges (if any) for excavation inside plant premises as applicable as per Govt. of Tamilnadu shall be reimbursable to the bidder by BHEL for the quantum of earth work done on submission of necessary proof of payments/challans as required by M/s NTPL for reimbursement and realization of reimbursement from NTPL to BHEL.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.7.7 ROYALTY FOR CONSTRUCTION MATERIALS

Payment of royalty for construction materials viz. coarse aggregates, fine aggregates, borrowed earth, etc. is to be made by contractor and challan of payment/deposit of royalty/ seigniorage fee shall be submitted to BHEL along with RA bill.

In absence of production of challan following methodology shall be adopted:

Sl. No.	Construction Material	Indicative Rate of seigniorage/ royalty to be withheld in RA bill	Volume to be considered for calculation	Remarks
1	Coarse aggregate	Rs. 59 per cum	A. For RCC: (As per approved design mix proportion + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill)	Rate mentioned herein is indicative and for information based on Gazette Notification with G.O. Ms. No. 183, Industries (MME.1), 28th December 2017. However, Actual prevailing rate for seigniorage fee/ royalty fee as per the Tamilnadu Government Gazette Notification shall be considered for operation in RA bills/ Final bill. The amount so calculated shall be withheld from RA bill and on production of challan, payment of relevant portion will be released.
2	Fine aggregate	Rs. 120 per cum	B. For PCC: (As per DSR recommendation + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill)	
3	Borrowed earth	Rs. 26 per cum	Actual volume of filling shall be considered	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Any additional amount deducted by NTPL from BHEL over and above the amount deducted from contractor based on above table, on account of royalty/seigniorage fee for construction materials, will be deducted from the contractor's bills.

1.7.8 **METHOD OF MEASUREMENT**

Mode of measurement shall be as per relevant IS 1200 in conjunction of IS code 3385. In case the same is also not available, the standard procedure adopted in CPWD shall be adopted. In case, the same is also not available in CPWD, the measurement of the work done will be based on the mutual agreement between BHEL and contractor. In all the above cases, the interpretation of BHEL will be final and binding to the contractor. Measurement guidelines as a ready reference is also available in the technical specification.

1.7.9 **NO CLAIM WHAT SO EVER MAY BE, WILL BE ENTERTAINED UNDER THIS CONTRACT, AFTER DULY SIGNING THE FINAL BILL ALONG WITH MEASUREMENT BOOKS AND ACCEPTED BY BHEL.**

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART-I CHAPTER - VIII

TAXES AND OTHER DUTIES

1.8.1 Goods and service Tax (GST) & Cess

- 1.8.1.1 The successful bidder shall furnish proof of GST registration with GSTN Portal in the State in which the Project is being executed, covering the services under this contract. Registration should also bear endorsement for the premises from where the billing shall be done by the successful bidder on BHEL for this project/ work.
- 1.8.1.2 Contractor's price/rates shall be exclusive of GST & Cess (if applicable) (herein after termed as GST). Contractor shall submit to BHEL the GST compliant tax invoice/debit note/revised tax invoice on the basis of which BHEL will claim the input tax credit in its return. Since this is a works contract, the applicable rate shall be @ 18% GST, as applicable presently
- 1.8.1.3 Bidder shall note that the GST Tax Invoice complying with GST Invoice Rules wherein the 'Bill To' details will as below:
- BHEL GSTN - 33AAACB4146P2ZL
 - NAME - BHARAT HEAVY ELECTRICALS LIMITED
 - ADDRESS - BHEL PSSR SITE OFFICE, 2X500 MW NTPL Project, Harbour Estate, Tuticorin, Pin code- 628004, Tamilnadu
- 1.8.1.4 GST charged in the tax invoice/debit note/revised tax invoice by the contractor shall be released separately to the contractor only after contractor files the outward supply details in GSTR-1 on GSTN portal and input tax credit of such invoice is matched with corresponding details of outward supply of the contractor and has paid the GST at the time of filing the monthly return.
- 1.8.1.5 In case BHEL has to incur any liability (like interest / penalty etc.) due to denial/reversal / delay of input tax credit in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.
- 1.8.1.6 Further, in case BHEL is deprived of the Input tax credit due to any reason attributable to contractor, the same shall not be paid or Recovered if already paid to the contractor.
- 1.8.1.7 Tax invoice/debit Note/revised tax invoice shall contain all such particulars as prescribed in GST law and comply to the timelines for issue of the same. Invoices shall be submitted on time to the concerned BHEL Engineer In Charge.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.8.1.8 TDS under GST (if/ as & when applicable) shall be deducted at prevailing rates on gross invoice value from the running bills.

1.8.1.9 E-way bills / Transit passes / Road Permits, if required for materials / T&P etc., bought into the project site is to be arranged by the Contractor only.

1.8.1.10 BHEL shall not reimburse any amounts towards any interest / penalty etc., incurred by contractor. Any additional claim at a later date due to issues such as wrong rates / wrong classification by contractor shall not be paid by BHEL.

1.8.2 All taxes and duty other than GST & Cess

The contractor shall pay all (except the specific exclusion viz GST & Cess) taxes, fees, license charges, deposits, duties, tools, royalty, commissions, Stamp Duties, or other charges / levies, which may be levied on the input goods & services consumed and output goods & services delivered in course of his operations in executing the contract and the same shall not be reimbursed by BHEL. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from his bills or otherwise as deemed fit.

1.8.3 Statutory Variations

Statutory variations are applicable under the GST Acts, against production of proof. The changes implemented by the Central / State Government during the tenure of the contract viz. increase / decrease in the rate of taxes, applicability, etc. and its impact on upward revision / downward revision are to be suitably paid/ adjusted from the date of respective variation. The bidder shall give the benefit of downward revision in favour of BHEL. No other variations shall be allowed during the tenure of the contract.

1.8.4 New Taxes/Levies

In case Government imposes any new levy / tax after submission of bid during the tenure of the contract, BHEL shall reimburse the same at actual on submission of documentary proof of payment subject to the satisfaction of BHEL that such new levy / tax is applicable to this contract.

1.8.5 Direct Tax

BHEL shall not be liable towards Income Tax of whatever nature including variations thereof arising out of this contract as well as tax liability of the bidder and their personnel. Deduction of tax at source at the prevailing rates shall be effected by BHEL before release of payment as a statutory obligation, unless exemption certificate is produced by the bidder. TDS certificate will be issued by BHEL as per the provisions of Income Tax Act.

VOLUME-IA PART-I CHAPTER -IX

BILL OF QUANTITY

1.9 BILL OF QUANTITY

- 1.9.1 Bidders shall only quote "Total amount" in the format given in price bid. Any other elsewhere in the price bid shall be treated as Null and Void.
- 1.9.2 The above mentioned "Total amount" is for the entire Bill of Quantity (BOQ) given in Part-C of the Price bid.
- 1.9.3 BHEL has the pre-fixed the weightages for the amount of individual items of Bill of Quantity with respect to the "Total amount" in Part-C.
- 1.9.4 Based on the pre-fixed weightages, the amount for the individual items of the Bill of Quantity shall be arrived at. This amount shall be rounded off to the nearest rupee.
- 1.9.5 Based on the quantities of individual item and the amount arrived in SI No. 1.9.4 above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.
- 1.9.6 Bidder to note that this is an item rate contract. Payment shall be made for the actual quantities of work executed at the unit rate arrived at as per SI No. 1.9.5 above.
- 1.9.7 Quantity variation shall be as per GCC Clause no. 2.14.
- 1.9.8 Schedule of Electrical equipments/ items have been indicated for reference only. All electrical items shall be supplied on as required basis as per Technical Specification.
- 1.9.9 Only brief description of items of work is given in the PRICE SCHEDULE. All the works are to be done as per tender specifications, descriptive notes and drawings to establish the complete facilities in all respects.
- 1.9.10 Unless otherwise specified rate against each item must be quoted for manufacture, fabrication, supply, loading, transportation, unloading, cartage, laying, construction, erection, painting, etc. including necessary statutory duties.

VOLUME-IA PART-I CHAPTER –X

GENERAL

In addition to the clause 2.8 of General Conditions of Contract (Volume-IC of Book-II) the contractor shall comply with the following.

- 1.10.1** Successful Bidder is requested to furnish the following at PSSR-HQ Chennai immediately after release of Letter of Intent (LOI)
- i. Security Deposit.
 - ii. Unqualified Acceptance for LOI.
 - iii. Unqualified Acceptance for Detailed LOI/ Work Order.
 - iv. Rs.100/- Stamp Paper for preparation of Contract Agreement.
- 1.10.2** Successful Bidders are requested to furnish the proof of documents for the following at PSSR- Site.
- i. PF Regn No.
 - ii. Labour License No.
 - iii. Workmen Insurance Policy No.
- 1.10.3 BOCW Act & BOCW Welfare Cess Act – Not Applicable**
- 1.10.4 PROVIDENT FUND**
- 1.10.4.1** The contractor is required to extend the benefit of Provident Fund to the labour employed by the contractor in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, the contractor is hereby required to get themselves registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to them by the Provident Fund authorities within one month from the date of issue of this letter of intent. In case the contractor is exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of contractor's failure to comply with the provisions of said Act, if recoveries therefore are enforced from payments due to BHEL by the customer or paid to statutory authorities by BHEL, such amount will be recovered from payments due to the contractor.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.10.4.2 The final bill amount would be released only on production of clearance certificate from PF / ESI and labour authorities as applicable.

1.10.5 OTHER STATUTORY REQUIREMENTS

- 1.10.5.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules and Valid WC Insurance copy or ESI Code (if applicable) and PF code no along with the first running bill.
- 1.10.5.2 The contractor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r78(1)(a)(1) of Contract Labour Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.
- 1.10.5.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of “Non-compliance of Sec 21 or non-payment of wages” to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.
- 1.10.5.4 The Contractor shall submit copies of Final Settlement statement of disbursement of retrenchment benefits on retrenchment of each workman under I D Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with Copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act 1948 (If applicable) to BHEL along with the Final Bill.
- 1.10.5.5 In case of any dispute pending before the appropriate authority under I D act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserve the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.
- 1.10.5.6 In case of any dispute prolonged/pending before the authority for the reasons not attributable to the contractor, BHEL reserves the right to release the final bill of the contractor on submission of Indemnity bond by the

TECHNICAL CONDITIONS OF CONTRACT (TCC)

contractor indemnifying BHEL against any claims that may arise at a later date without prejudice to the rights of BHEL

1.10.6 DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN

The following clause is applicable in case the contract value / contract price is Rs. Five crores and above. The contractor shall, at all stages of work deploy skilled / semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute / Industrial Training. Institute / National Institute of Construction Management and Research (NICMAR), National Academy of Construction, CIDC or any similar reputed and recognized Institute managed / certified by State / Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled / semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

1.10.7 GENERAL

1.10.7.1 Site Visit by the Bidder

The bidder shall, prior to submitting his tender for the work, visit, examine the site of works and its surroundings at his own expense, and obtain and ascertain for himself on his own responsibility all information that may be necessary for preparing his tender and entering into a contract, and take the same into account in the quoted contract price for the work.

The bidder shall satisfy themselves about the following factors:

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- i. Site conditions including access to the site, existing and required roads and other means of transport/communication for use by him in connection with the work including diverting and re-routing of services.
- ii. Requirement and availability of land and other facilities of his enabling works, establishment of his nursery, office, stores etc.
- iii. Ground conditions including those bearing upon transportation, disposal, handling and storage of materials required for the work or obtained there- from.
- iv. Source and extent of availability of suitable materials, including water etc., and labour (skilled and unskilled) required for work, and laws and regulations governing their use and employment.
- v. Geological, meteorological, topographical and other general features of the site and its surroundings as are pertaining to and needed for the performance of the work.
- vi. The limit and extent of surface and subsurface water to be encountered during the performance of the work, and the requirement of drainage and pumping.
- vii. The type of equipment and facilities needed, for and in the performance of the work.
- viii. The extent of lead and lift required for the work in complete form over the entire duration of the contract, and
- ix. All other information pertaining to and needed for the work including information as to the risks, contingencies and other circumstances which may influence or affect the work or the cost thereof under this contract.

- 1.10.7.2 The bidder should note that information, if any, in regard to the local conditions, as contained in these tender documents, has been given to tenderer merely for guidance and is not warranted to be complete.
- 1.10.7.3 A bidder shall be deemed to have full knowledge of the site, whether he inspects it or not, and no extra charges consequent on any misunderstanding or otherwise shall be allowed.
- 1.10.7.4 The bidder and any of his personnel or agents will be granted permission by the Site-In-Charge or his authorized nominee, on receipt of formal application in respect thereof a week in advance of the proposed date of inspection of site, to enter upon his premises and lands for purpose of such

TECHNICAL CONDITIONS OF CONTRACT (TCC)

inspection, but only on the express condition that the tenderer (and his personnel and agents) will relieve and indemnify the Employer (and his personnel and agents) from and against all liability in respect thereof and will be responsible for personal injury (whether fatal or otherwise), loss of or damage to property and any other loss, damage, costs and expenses however caused which, but for the exercise of such permission, would not have arisen.

- 1.10.7.5 All works shall be carried out in proper workmen like manner. Items of works covered by the following specification shall be carried out as per the best practices and according to the direction of the Engineer In- charge / BHEL, Site Engineer and to his satisfaction. Unless otherwise specified in this section or in the description of item, the cost of stage of works mentioned here under shall be deemed to have been included in the rates of items provided in the schedule
- 1.10.7.6 Scope of work covered under this specification requires quality workmanship, engineering and construction management. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments, etc. in his possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled personnel. The manpower deployment identified by contractor shall match with above scope of works.
- 1.10.7.7 It is not the intent to specify herein all details of all material. Any item related this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work
- 1.10.7.8 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there at no extra cost.
- 1.10.7.9 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.
- 1.10.7.10 The contractor shall carryout additional tests, if any, which the Engineer feels necessary because of site conditions and also to meet system specification
- 1.10.7.11 The work shall be executed under the usual conditions without affecting power plant construction and in conjunction with other operations and contracting agencies at site. The contractor and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with

TECHNICAL CONDITIONS OF CONTRACT (TCC)

others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

- 1.10.7.12 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. The contractor shall co-operate with other contractors and agencies so that various activities can be carried out simultaneously in order to achieve an early completion
- 1.10.7.13 All the work shall be carried out as per instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the contractor.
- 1.10.7.14 Wherever Work sequences are furnished by BHEL, the contractor shall follow the same sequence.
- 1.10.7.15 Contractor shall execute the supply and works as per sequence prescribed by BHEL at site engineer. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of execution of similar job in any other site or for any reasons whatsoever.
- 1.10.7.16 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.
- 1.10.7.17 Contractor shall, transport all materials to site and unload at site / working area for inspection and checking. All material handling equipment required shall be arranged by the contractor.
- 1.10.7.18 The contractor will be responsible for the safe custody and proper accounting of all materials in connection with the work.
- 1.10.7.19 The contractor must obtain the signature and permission of the security personnel of the customer for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside
- 1.10.7.20 Contractor shall retain all T&Ps, Material handling equipments etc at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from Engineer In-charge.
- 1.10.7.21 The contractor at his cost shall arrange necessary security measures for adequate protection of his machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor's construction equipment and materials. The contractor may consult the

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.
- 1.10.7.22 Any wrong erection shall be removed and re-erected promptly to comply with the design requirements to the satisfaction of Site Engineer
- 1.10.7.23 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. However, completion time for construction, agreed will be subject to the condition that contractor's work is not hampered by the agencies.
- 1.10.7.24 Contractor has to work in close co-ordination with other agency at site. BHEL engineer will co-ordinate area clearance. In a project of such magnitude, it is possible that the area clearance may be less / more at a particular given time. Activities and Construction program have to be planned in such a way that the milestones are achieved as per schedule/ plans. Contractor shall arrange & augment the resources accordingly.
- 1.10.7.25 Contractor shall remove all scrap materials periodically generated from his working area in and around power station and collect the same at one place earmarked for the same. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect. All the package materials, including special transporting frames, etc. shall be returned to the BHEL stores by the contractor.
- 1.10.7.26 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.
- 1.10.7.27 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe / tubes, and handrails etc. for any temporary supporting or scaffolding works. Contractor shall arrange himself all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.
- 1.10.7.28 No member of the already erected structure / platform, pipes, grills, platform, other component and auxiliaries should be cut without specific approval of BHEL engineer.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.10.7.29 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on ISO 9001 - 2015 Standards.
- 1.10.7.30 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.
- 1.10.7.31 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.
- 1.10.7.32 On Completion of work, all the temporary buildings, structures, pipe lines, cable etc. shall be dismantled and leveled and debris shall be removed as per instruction of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.
- 1.10.7.33 It is the responsibility of the contractor to do the checking, testing etc. if necessary, repeatedly to satisfy BHEL Engineer with all the necessary tools and tackles, manpower etc. without any extra cost. The testing will be completed only when jointly certified so, by the BHEL Engineer.
- 1.10.7.34 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.
- 1.10.7.35 If any item not covered but requires being executed, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.
- 1.10.7.36 The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities will be penalized and contractor shall be responsible for cost for such damages.
- 1.10.7.37 Contractor shall retain all T&Ps, Material handling equipments etc at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from Engineer In charge

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.10.8 SITE INSPECTION

- 1.10.8.1 BHEL or his authorized agents may inspect various stages of work during the currency of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.
- 1.10.8.2 BHEL will have full power and authority to inspect the works at any time, either on the site or at the contractor's premises. The contractor shall arrange every facility and assistance to carry out such inspection. On no account will the contractor be allowed to proceed with work of any type unless such work has been inspected and entries are made in the site inspection register by BHEL
- 1.10.8.3 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, delay in execution of work or any other matter, BHEL shall have the right to engage labour at normal ruling rates and get the work executed through other agency and debit the cost to the contractor and the contractor shall have no right to claim compensation thereof. In such a case, BHEL shall have the right to utilize the materials and tools brought by the contractors for the same work

1.10.9 DOCUMENTATION

- 1.10.9.1 The following information shall be furnished by the bidder within two weeks of award of contract for purchaser's approval:
- a) Bar chart covering planned activities at site
 - b) Detailed organization chart
 - c) Details of T&P available with contractors with documents proofs.
- 1.10.9.2 The following information shall be furnished by the bidder after testing and inspection: Test certificates of various tests conducted at site. All inspection and test certificates shall be signed by BHEL representative also.

VOLUME-IA PART-I CHAPTER X

ACCOUNTING OF MATERIALS ISSUE

1.11 ACCOUNTING OF MATERIALS ISSUE

The material issued to the contractor by BHEL will be accounted as follows:

1.11.1 ISSUE OF CEMENT, CONSUMPTION, WASTAGE & RETURN OF MATERIALS

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.11.2 ISSUE OF STEEL, CONSUMPTION, WASTAGE & RETURN OF MATERIALS

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.11.3 SCRAP & SERVICEABLE MATERIALS:

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.11.4 BOROSILICATE GLASS BLOCK LINING SYSTEM

1.11.4.1 The borosilicate lining material (including closed cell borosilicate glass blocks, adhesive/ membrane and compatible primer paint) issued by BHEL shall be properly accounted (issue and reconciliation).

1.11.4.2 The borosilicate lining material as received from the manufacturer/ stockiest will be issued free of cost to the contractor. Necessary documents are to be submitted by the contractor to the BHEL stores for having received the materials.

1.11.4.3 Bidder is responsible for sampling and testing of borosilicate materials (if insisted by BHEL) as per Indian Standard/ Specification / approved quality plan in the testing laboratory established by the bidder.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.11.4.4 CONSUMPTION AND WASTAGE OF BOROSILICATE LINING MATERIAL

a) CONSUMPTION

The theoretical consumption of Borosilicate Lining material shall be based on approved drawing & installation procedure.

- i. Actual consumption = Issue – Surplus.
- ii. Surplus = Untampered & unused quantity of material
- iii. Wastage = Actual consumption – Theoretical consumption

b) WASTAGE

Wastage shall be as per below table.

S.NO	CONSUMPTION OF BOROSILICATE LINING MATERIAL	BASIS OF ISSUE
B-1	Theoretical consumption as per drawing	Free
B-2	Wastage of the aforesaid theoretical consumption (B-1) towards allowable wastage is limited to i. Borosilicate Glass Blocks – two percent (+2%) ii. Adhesive membrane – eight percent (+8%) iii. Primer – six percent (+6%)	Free
B-3	Wastage beyond allowable wastage (B-2) of the aforesaid theoretical consumption (B-1)	Penal Rate

Note – The wastage percentage mentioned in B-2 of above table shall be on the unit of measurement as supplied by the Borosilicate glass block supplier.

The wastage mentioned above include wastage which is generated during loading, unloading, transportation, storage, handling and application activities.

1.11.5 RECONCILIATION OF MATERIALS

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural
Chapter – VI: Material Handling, Storage & Preservation

1.11.6 RECOVERY OF MATERIAL

Recovery of wastages shall be made from the bills of contractor at the penal rate mentioned in the table below for the following cases:

- a) If wastage exceeds the specified limit
- b) If the wastage not exceeded specified limit, but not returned to BHEL store except invisible wastage
- c) For not returning the surplus serviceable materials

1.11.7 PENAL RATE OF MATERIALS

S. NO.	DESCRIPTION	PENAL RATE (RS. PER UNIT)
A	REINFORCEMENT STEEL HCRM Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	Rs. 76,871/- per MT + GST and/or other taxes & duties
B	STRUCTURAL STEEL – LONG PRODUCTS Rolled steel Beams, channels, and angles, etc. in sizes and lengths as available.	Rs. 70,334/- per MT + GST and/or other taxes & duties
C	STRUCTURAL STEEL – FLAT PRODUCTS MS plates, MS flats, MS pipes, Chequered Plates, etc. in sizes and lengths as available	Rs. 76,204/- per MT + GST and/or other taxes & duties
D	CEMENT OPC 43 GRADE	Rs. 6,153/- per MT + GST and/or other taxes & duties
E	BOROSILICATE GLASS BLOCK LINING SYSTEM Borosilicate Glass Blocks, Adhesive Membrane & Primer Paint	Actual cost of procurement per sqm + 5 % overhead + GST and/or other taxes & duties

VOLUME-IA PART – I CHAPTER – XII

PROGRESS OF WORK

1.12 PROGRESS OF WORK

1.12.1 PROGRESS AND MONITORING OF WORK

Refer forms F -14 and F-15 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

1.12.2 Contractor is required to draw mutually agreed monthly construction programs in consultation with BHEL well in advance monthly as per the Form-14. Contractor shall ensure achievement of agreed program and shall also timely arrange additional resources considered necessary at no extra cost to BHEL. Progress review meetings will be held at site during which actual progress during the week vis-a-vis scheduled program shall be discussed for actions to be taken for achieving targets. Contractor shall also present the program for subsequent week. The contractor shall constantly update / revise his work program to meet the overall requirement. All quality problems shall also be discussed during above review meetings. Necessary preventive and corrective action shall be discussed and decided upon in such review meetings and shall be implemented by the contractor in time bound manner so as to eliminate the cause of nonconformities.

1.12.3 The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials report, consumables (gases / electrodes / ferules / lugs) report, T&Ps availability report and other reports as per Performa considered necessary by the Site Engineer as per the BHEL formats.

1.12.4 The contractor shall submit weekly/ fortnightly/ monthly statement report regarding consumption of all consumables for cost analysis purposes.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1.12.5 The monthly report ending on 24th of every month shall be submitted as a booklet and shall contain the following details: -

- a) Colour Progress photographs to accompany the report should be submitted.
- b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.
- c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan.
- d) Category-wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.
- e) Consumables report giving consumption of all types of gases and electrodes during the previous month.
- f) Availability report of cranes/T&Ps.
- g) Safety implementation report in the format.
- h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.

1.12.6 The manpower reports shall clearly indicate the manpower deployed, category wise specifying also the activities in which they are engaged.

1.12.7 During the course of construction, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians etc. employed are not sufficient BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this

TECHNICAL CONDITIONS OF CONTRACT (TCC)

account including all expenses together with BHEL overheads from contractor's bills.

- 1.12.8** It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, labour availability, equipment deployment, testing, etc.
- 1.12.9** The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.
- 1.12.10** The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

VOLUME-IA PART-I CHAPTER-XII

MATERIAL HANDLING

1.13 MATERIAL HANDLING

- 1.13.1** Contractor shall maintain one centralized fenced store cum bar bending yard at his own cost. Hard surfacing of this yard and all round drain shall be carried out by the contractor at his own cost within the quoted rate. Batching plant area, shall be installation in the space provided by BHEL/ NTPL and operation of the Batching Plant at his own cost. The bidder shall make complete arrangement of necessary security personnel, to safeguard all such materials in his custody at his own cost. Materials issued will be used only for construction of permanent work. The contractor shall take care of material issued by BHEL and shall protect the same from theft, damage and weathering at his own cost.
- 1.13.2** The system for receipt, storage & issue of materials shall be available with vendors for easy traceability.
- 1.13.3** Periodic audit of system of purchasing, storing and issue, etc. will have to be carried out by the vendors. BHEL will also audit the same.
- 1.13.4** As applicable, the contractor shall construct waterproof cement store (capacity 400MT) at his own cost for initial period for storing and stacking of cement, CGI/ asbestos roofing (slope) with brick masonry wall, PCC flooring. Materials required for the same shall be provided by contractor at his own cost. Cement has to be kept over wooden raised platform. Stacking of cement is to be done as per IS codes with proper illumination and locking arrangements.
- 1.13.5** The contractor shall in no case be entitled for any compensation or damages on account of any delay in supply or non-supply thereof for all or any such material.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.13.6** Clotting of cement and excessive rusting of steel must be avoided. In case, due to any cause/reason attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of cement & steel shall be recovered from the interim payment at the penal rate specified in the tender.
- 1.13.7** The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of once in every month (along with running bill) computerized reconciliation statement of such account to the BHEL.
- 1.13.8** All TMT shall be stacked over sleeper's diameter wise.
- 1.13.9** All structural steel shall be stacked plate size wise and thickness wise beams, channels and angles shall be stacked separately on sleepers.
- 1.13.10** Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART – II CHAPTER 1

CORRECTIONS / REVISIONS IN SPECIAL CONDITIONS

OF CONTRACT

SI No: 1

OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT MANAGEMENT/ QUALITY ASSURANCE PROGRAMME

The following clauses in Occupational Health, Safety & Environment Management / Quality Assurance Programme published in Chapter-IX of Special Conditions of Contract (Volume I Book-II) is revised as under.

Chapter IX Clause 9.1 is modified as below:

Contractor will comply with HSE (Health, Safety & Environment) requirements of BHEL as per the “HSE Plan for Site Operations by Subcontractor” (Document No. HSEP: 14 Rev01) enclosed.

Chapter IX Clause 9.1.1 to 9.1.25 stands deleted.

Chapter IX Clause 9.2 to 9.62 stands deleted.

Following Clauses are modified in the Special Conditions of Contract (SCC)

SI No: 2

Following Clauses are modified in the Special Conditions of Contract (SCC)

SCC Clause Ref.	Existing Clause	Modified as
Clause no. 6.3.4.1	The steel shall be issued to the contractor on the following basis: i. Structural Steel: Weighment basis (Unit – MT) ii. Reinforcement Steel and Earthing Rod: Weighment basis (Unit-MT) iii. MS Rails: Weighment Basis (Unit-MT)	The steel shall be issued to the contractor on the following basis: i. Structural Steel: Weighment basis (Unit – MT) ii. Reinforcement Steel and Earthing Rod: Weighment basis (Unit-MT)
Clause no. 6.3.4.2	All the steel (structural, reinforcement, earthing rod/GI flats, GI foundation bolts, etc.) IS/BS/EN specifications.	All the steel (structural, reinforcement, earthing rod, etc.) IS/BS/EN specifications.”

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SCC Clause Ref.	Existing Clause	Modified as
Heading of Clause no. 6.4.4.3	Reinforcement Steel, MS earthing rod, GI gratings, Foundation bolts and MS Rails Consumption	Reinforcement Steel, MS earthing rod Consumption
Heading of Clause no. 6.4.4.4	Reinforcement Steel, MS earthing rod, Foundation bolts and MS Rails Wastage	Reinforcement Steel, MS earthing rod Wastage
Clause no. 6.4.4.7 a	The contractor shall submit a reconciliation statement of cement and steel issued to the contractor with each RA Bill.	The contractor shall submit a reconciliation statement of borosilicate lining materials, cement and steel issued to the contractor with each RA Bill

SI No: 3

Following Clauses are added in the Special Conditions of Contract (SCC)

6.3.4.9 Bidder to note that steel materials required for MS Grating, Galvanised Grating, GI Handrail, Stainless Steel Handrail, Stainless steel for SS Flue can, fasteners like MS/HT/HSFG bolts/nuts, lock nuts, washers and foundation bolts, embedded items other than those supplied by BHEL, etc. shall be supplied by the bidder. However, Bidder shall use the scrap materials for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities and shall be accounted for monthly reconciliation.

6.3.4.10 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

SL NO	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE
1.	Reinforcement Steel & Earthing rod MS round	Requirement of one month
2.	Structural Steel	Requirement of one month

6.3.5 ISSUE OF CEMENT

6.3.5.1 Cement as received from the manufacturer/ stockiest will be issued **free of cost** to the contractor. The cement shall be provided normally in bulkers and shall be unloaded in the silos (2 numbers cement silos 100MT capacity each of cumulative capacity of 200 MT per 30 CUM batching plant) to be installed by the

TECHNICAL CONDITIONS OF CONTRACT (TCC)

bidder nearer to their batching plants. Cement unloading arrangements to silo and required manpower support shall be provided by the successful bidder at his own cost.

- 6.3.5.2 On advance request of the bidder, the cement shall be supplied in 50kg tamper proof sealed Bags for other than RCC works like masonry, flooring works etc. The theoretical weight of each bag of cement for issued purposes will be considered as 50 kg, the contractor shall be accountable for the cement issued to him on this notional weight only. No claim whatsoever will be entertained because of difference between theoretical and actual weight of the bags of cement. The empty cement bags duly accounted for against issue shall be in the custody of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project.
- 6.3.5.3 The contractor shall submit to the engineer, a statement indicating estimated quantity of cement required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of cement during a month by the third week of the previous month indicating his requirement.
- 6.3.5.4 Bidder is responsible for unloading the cement as soon as the arrival of cement, either in silo, if received in bulker or in the weather proof cement storage sheds, if received bags. Bagged cement shall be stored in a weatherproof sheds having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the owner before any cement is delivered to site. The construction of cement storage sheds as per the requirement of BHEL, unloading of cement bags, stacking properly in the storage sheds, removal of the sheds after the completion of the work is in the scope of bidder.
- 6.3.5.5 Bidder is responsible for sampling and testing of cement as per Indian Standard/ Specification/ approved quality plan in the testing laboratory established by the bidder.
- 6.3.5.6 Bidder is responsible for carrying out design mix as per IS 456/10262 Latest revision and specification, using the cement provided by BHEL and submit the design mix proportions for the approval of BHEL/NTPL. The design/trial mix shall be carried out time to time on change of brand/type of cement supplied by BHEL and suitable adjustments on the quantity of ingredients (sand, aggregates, admixture) of the concrete to get the required workability and durability, shall be the responsibility of the bidder without any extra cost to BHEL.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

6.3.5.7 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

SL NO	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE
1.	Cement	Requirement of one month

SI No: 3

The second para under Clause 10.5 of Special Conditions of Contract (SCC) stands deleted. Accordingly, the said clause is modified as under:

SCC Clause Ref.	Existing Clause	Modified as
Clause no. 10.5	The payment for running bills will normally be released within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc. and other dues in the meanwhile. 60% of RA Bills complete and correct in all respects and certified by BHEL Engineer, shall be paid within 15 days of receipt. Balance payment shall be within 30 days.	The payment for running bills will normally be released within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc. and other dues in the meanwhile.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART – II CHAPTER 2 to 5

In the next 1294 pages as below:

Chapter	Details	No of sheets
Chapter - 2	Technical Specifications	1201
Chapter - 3	Bid drawings	01
Chapter - 4	Health, Safety and Environment Plan for Site Operation By Subcontractors	82
Chapter - 5	Hire charges on issue of capital tools & Plants (Only corresponding charges)	10



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : C

REV.NO. 00

SHEET

2X500 MW NTPL TUTICORIN CHIMNEY PACKAGE

VOLUME II-B

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

SECTION-C SPECIFIC TECHNICAL REQUIREMENTS (RCC CHIMNEY)

**SPECIFICATION NO. PE-TS-490-620-C002
REV-00**



Bharat Heavy Electricals Limited

**Project Engineering Management
Power Sector, PPEI BUILDING, Plot No-25
SECTOR 16A, NOIDA-201301, UP**

	TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY PACKAGE SPECIFICATIONS FOR RCC CHIMNEY	SPECIFICATION NO. PE-TS-490-620-C002
		VOLUME : IIB
		SECTION : C
		REV.NO. 00
		SHEET

PREAMBLE

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

Technical requirements are stipulated in this Volume which comprises of

Section C : This section indicates the technical requirements specific to the contract not covered in Section D

Section D : This section comprises of technical specification(s)

The requirements mentioned in the Section C shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the Section D in the specification. In case on any conflict between technical specification and BOQ, BOQ shall prevail.

	TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY PACKAGE SPECIFICATIONS FOR RCC CHIMNEY	SPECIFICATION NO. PE-TS-490-620-C002
		VOLUME : IIB
		SECTION : C
		REV.NO. 00
		SHEET

INDEX

SECTION	DESCRIPTION
Section-C	SPECIFIC TECHNICAL REQUIREMENTS
Section-D	SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : C

REV.NO. 00

SHEET

SECTION-C

SPECIFIC TECHNICAL REQUIREMENTS (RCC CHIMNEY)



**NLC TAMILNADU POWER LTD.
2 X 500 MW PROJECT
TUTICORIN, TAMIL NADU**

**TENDER SPECIFICATION
FOR
CHIMNEY**

VOLUME: II

TECHNICAL SPECIFICATION



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED
CONSULTING ENGINEERS
BLOCK DG-4, SECTOR-II, SALT LAKE CITY
KOLKATA- 700 091, INDIA**

July, 2020

NLC TAMIL NADU POWER LTD.

2 x 500 MW PROJECT

TUTICORIN, TAMIL NADU.

**Construction of One RCC Additional Chimney of 150 M height with
Borosilicate lined Bi-flue can arrangement for Flue Gas Desulphurization
Plant of 2X500 MW Coal based Thermal Power Plant located at Tuticorin,
Tamil Nadu, India.**

OVERALL CONTENTS

VOLUME – IA	:	Invitation for Bid
VOLUME – IB	:	Draft Contract
VOLUME II-A	:	Lead Specification including Project Management and Site Services
VOLUME II-B Sec I Part-A	:	General Technical Specification for Civil and Structural Works
VOLUME II-B Sec I Part-B	:	Civil Specification for Chimney structures
VOLUME II-B Sec I Part-C	:	Specific Design requirements of Civil
VOLUME II-B Sec II	:	Stack Elevator
VOLUME II-B Sec III	:	Electrical
VOLUME - III	:	Bid-Proposal Sheets [Technical Part]

**NLC TAMIL NADU POWER LTD.
2 X 500 MW PROJECT
TUTICORIN, TAMIL NADU**

OVERALL CONTENTS

VOLUME-I	:	General Conditions of Contract
VOLUME-II	:	Technical Specification
VOLUME-III	:	Bid Proposal Sheets [Technical Part]



CONTENTS

VOLUME-II	TECHNICAL SPECIFICATION
VOLUMES	DESCRIPTION
VOLUME II-A	: Lead Specification
VOLUME II-B	: Technical Specification For Chimney



CONTENTS

VOLUME: II-A

LEAD SPECIFICATION

SECTIONS

DESCRIPTION

SECTION-I	:	Lead Specification
SECTION-II	:	Project Management And Site Services
SECTION-III	:	Engineering Services



CONTENTS

VOLUME : II-B

TECHNICAL SPECIFICATION FOR CHIMNEY

SECTIONS

DESCRIPTION

SECTION - I **TECHNICAL SPECIFICATIONS FOR CHIMNEY (CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS)**

PART A **Common Part of Both Chimney Structure and Other than Chimney Structures**

SUB SECTION-I Geotechnical Investigation

SUB SECTION-II Area Grading

SUB SECTION-III Earthwork In Excavation And Backfilling

SUB SECTION-IV Cement Concrete - Plain & Reinforced

SUB SECTION-V Bored Cast-In-Situ Concrete Pile

SUB SECTION-VI Fabrication Of Structural Steel Work

SUB SECTION-VII Erection Of Structural Steel Work

SUB SECTION-VIII Roads And Drainage

SUB SECTION-IX Properties, Storage And Handling Of Common Building Materials

PART B **For Chimney Structures Only**

SUB SECTION-I General Specification And Design Criteria Of Chimney – Civil & Structural Works

SUB SECTION-II Technical Specification For Construction Of Reinforced Concrete Chimney

PART C **Other than Chimney Structures**

SUB SECTION-I Specific Design Criteria - Civil

SUB SECTION-II Specific Design Criteria - Structural

SUB SECTION-III General Specification And Design Criteria For Architectural Works

SUB SECTION-IV Masonry And Allied Works

SUB SECTION-V Finish To Masonry And Concrete

SUB SECTION-VI Metal Doors, Windows, Ventilators, Louvres, Curtain Wall, Structural Glazing, Etc.

SUB SECTION-VII Anti-Termite Treatment



SUB SECTION-VIII	Rolling Steel Shutters, Grills And Collapsible Doors
SUB SECTION-IX	Glass And Glazing
SUB SECTION-X	Floor Finishes And Allied Works
SUB SECTION-XI	Painting, White Washing And Polishing Etc.
SUB SECTION-XII	Roof Water Proofing, Insulation And Allied Works
SUB SECTION-XIII	Water Supply
SUB SECTION-XIV	Drainage And Sanitation
SUB SECTION-XV	Fly Ash Blocks / Bricks

SECTION-II TECHNICAL SPECIFICATIONS FOR STACK ELEVATOR

SECTION-III TECHNICAL SPECIFICATIONS FOR CHIMNEY– ELECTRICAL WORKS

SUB SECTION-I	General Electrical Specification
SUB SECTION-II	A.C. Motors
SUB SECTION-III	Power Distribution Board
SUB SECTION-IV	Illumination
SUB SECTION-V	Cables
SUB SECTION-VI	Uninterruptible Power Supply (UPS)
SUB SECTION-VII	Grounding And Lightning Protection
SUB SECTION-VIII	Erection

ATTACHMENTS

DRAWINGS

- 18A09-DWG-C-0001 General Arrangement of 150 m high Bi-flue Chimney
- 18A09-CHM-DWG-E-0002 Single Line Diagram-Chimney Power Distribution Layout Chimney Arrangement





**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

DOMESTIC COMPETITIVE BIDDING

Tender No: COCONTS/ 0010 K/RT/NTPL/Addl. Chimney /2020, Dt. 01.07.2020.

Date & Time of Opening: 04.08.2020 at 15.00 Hrs. (IST)

TENDER SPECIFICATION

for

**Construction of One RCC Additional Chimney of 150 M height with
Borosilicate lined Bi-flue can arrangement for Flue Gas Desulphurization
Plant of 2X500 MW Coal based Thermal Power Plant located at Tuticorin,
Tamil Nadu, India.**

VOLUME – II A

LEAD SPECIFICATION INCLUDING PROJECT MANAGEMENT AND SITE SERVICES



Development Consultants Pvt. Ltd.

July 2020



VOLUME: IIA
LEAD SPECIFICATION
SECTION-I
CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTENT OF SPECIFICATION	2
2.00.00	QUALIFICATION OF BIDDER	3
3.00.00	PROJECT SYNOPSIS & GENERAL INFORMATION	3
4.00.00	SCOPE OF SUPPLY & SERVICES	4
5.00.00	TERMINAL POINTS	6
6.00.00	EXCLUSIONS	6
7.00.00	FACILITIES TO BE PROVIDED BY OWNER	6
8.00.00	DRAWINGS / DOCUMENTS TO BE FURNISHED BY BIDDER ALONG WITH BID	7
9.00.00	DRAWINGS / DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT	7
10.00.00	LAYOUT	9
11.00.00	WORKMANSHIP	9
12.00.00	TEMPORARY WORK	10
13.00.00	SEQUENCE OF WORK AND PROGRESS REPORT	10
14.00.00	TIME OF COMPLETION	10





SECTION-I

LEAD SPECIFICATION

1.0.0 INTENT OF SPECIFICATION

1.1.0 GENERAL

This specification is intended to cover generally all the civil and structural work including all accessories, piling and foundation raft, painting etc. as necessary for the construction of a 150 M High twin flue (with borosilicate lining) RCC Chimney for discharging hot flue gas from the Boilers to the atmosphere. The specification also include all the electrical and mechanical items such as electrical power receiving, distribution, grounding, illumination, lightening protection, rack and pinion elevator and all other accessories needed to complete the chimney ready in all respects for its proper functioning.

The scope under this package will start from the terminal points of the flue ducts, covered under Other Package, terminating outside the windshield.

The scope of work under this specification has been delineated in details under clause No. 4.0.0.

1.2.0 CONTENT OF SPECIFICATION

The specification consists of Volumes-I, II, & III detailed index of which has been furnished in the respective volumes. This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points. Any variation arising during detailed engineering stage and erection & services will be taken into account by the Successful Bidder within his scope and time of completion.

The Bidder shall be responsible for providing all material, equipment and services specified or otherwise which are required to meet the intent and scope of this specification, ensuring high degree of reliability and ease of operation and maintenance. The civil construction, electrical & stack elevator shall conform to all aspects of high standards of engineering, design and workmanship and shall be capable of performing in continuous operation, in a manner acceptable to the Owner and shall also be in line with the current practice for reliable and efficient functioning.

1.3.0 INTERPRETATION

Owner shall interpret the meaning of the specification, drawings, requirement of materials of construction, construction methods, maintenance, etc., and shall have a right to reject or accept any work or material which in his assessment is not technically complete to meet





the requirements of this specification and/or applicable National and International standards mentioned, elsewhere in this specification.

Bidder is required to carefully examine and understand the specifications and seek clarifications, if required, to ensure that he has understood the specifications as intended by the Owner. In the absence of any specific clarifications sought by the bidder during bidding stage, the interpretation of Owner shall be final. The Bidder's offer should not carry any sections like clarifications, interpretations and/ or assumptions. All such points are required to be clarified during the bidding stage.

In the event of conflict between requirements of any two clauses of these specification/ documents or requirements of different codes/ standards, specified, the more stringent requirement as per the interpretation of the Owner shall apply and shall be binding to the Bidder.

In case all the above requirements are not complied with, the offer may be considered as incomplete and liable to be treated as non-responsive and rejected.

1.4.0 BRAND NAME

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood as establishing type, function and quality desired.

1.5.0 DISCREPANCY

In case there is any difference of content/ information between "Hard Copy" and "Soft Copy" of this specification document, the statement/ information as printed in hard copy shall prevail.

2.0.0 QUALIFICATION OF BIDDER

Bidder and his associates, sub-contractor(s) for sub-systems shall satisfy the Qualifying Requirements as detailed in "Volume - I: Conditions of Contract" for RCC Chimney Package.

Bidder shall furnish the details of their credentials as per instruction of General Conditions of Contract in Volume-I.

3.0.0 PROJECT SYNOPSIS AND GENERAL INFORMATION

3.1.0 PROJECT SYNOPSIS

NLC Tamil Nadu Power Limited (NTPL) is presently operating a thermal power plant having two units of 500 MW capacity each, in Tuticorin, Tamil Nadu.

The Bidder shall acquaint himself with the conditions prevailing at site by a





visit to the site, before submission of the bid. The information given herein under is for general guidance and shall not be contractually binding on the Owner. All relevant site data /information as may be necessary shall have to be obtained/ collected by the Bidder.

3.2.0 APPROACH TO SITE

The site is accessed by National Highway No. 7A adjacent to plant. Due South connecting Madurai. The nearest railway station is Port Trust Railway Yard at a distance of 1.0 km. Tuticorin sea port is located adjacent to the plant. Nearest airstrip is located at Pudukottai at a distance of 16.5 km. Nearest town is Tuticorin, which is located 5.5 km away from the plant and nearest city is Pallayamkottai, 60 km away from the plant.

3.3.0 SALIENT METEOROLOGICAL DATA

For the purpose of equipment design, the following Meteorological data of site (as per IMD Tuticorin) shall be taken into consideration

a) Ambient temperature	:	36.5 °C maximum 20.8 °C minimum
b) Extreme Ambient temperature	:	36.4 °C maximum (Annual) 24.1 °C minimum (Annual)
d) Relative humidity	:	
(i) Maximum		82%
(ii) Minimum		35%
(iii) Average		57 to 68%
e) Annual Rainfall	:	437 mm
f) Wind load (refer Vol-IIB also)	:	In accordance with IS-875, Part-3
g) Seismic Zone edition.	:	Zone II as per IS: 1893 latest
h) Altitude	:	1.46 M above MSL

4.00.00 SCOPE OF SUPPLY AND SERVICES

4.01.00 CIVIL WORKS

All Civil and Structural works for One (1) no. RCC Bi-flue Chimney 150 m high twin flue with borosilicate lining enclosed by RCC windshield to suit MOEF norms with Internal & External Platforms, ladders for access to roof top, Rack





& Pinion elevator etc. complete with all accessories and other associated system /subsystem consisting of, but not limited to, the followings:-

- All Civil and structural works for RCC Bi-flue Chimney 150M high with insulated / lined (borosilicate) steel flues enclosed by RCC Wind Shield to suit MOEF norms with Rack & Pinion Elevator.
- Other Auxiliaries, Internal Steel Platforms, External RCC Platforms, ladders, Rack & Pinion elevator etc.
- Structural steel staircase upto the top internal platform of the chimney
- Duct supporting arrangements as per functional requirements
- Electrical-cum-C&I building / Analyzer shelter to accommodate extractive type analyzer Panels, Data loggers / PC, DB and other necessary accessories. This will be a RCC framed-structured single-storey building (of adequate size to meet the electrical and C&I functional / layout requirements as mentioned elsewhere) with RCC roof. This building shall be provided to satisfy all functional and operational requirements of Electrical / C&I systems as specified elsewhere.
- Peripheral Roads / Paving (as required) along with Street Lighting.
- Service Drains as necessary.

The Reinforced Concrete Bi-flue Stack of 150M high shall comprise of two nos. lined (with Borosilicate) steel flues enclosed by a wind shield of reinforced concrete shell to suit MOEF norms with R&P Elevator.

The scope of this work shall consist of, but not limited to, the design and construction of reinforced concrete windshield, foundations with associated pipe work, Borosilicate lining, internal/external stairs, cage ladders, elevator, platforms, walkways as specified or required for operation and maintenance, access doors, galvanized MS handrails, steel fittings, fixtures, inserts including fabrication, galvanizing and erection of associated steel work and other chemicals on the completed structures etc. all complete as per functional requirements and as per directions of Owner.

For complete Civil-Structural scope and guidelines, Refer to Vol-II-B-Section-I-Part B; Subsection-I and II of this specification.

4.02.00 ELECTRICAL AND OTHER WORKS

Bidder shall refer Section-III of Vol. IIB for Electrical works.

4.03.00 MECHANICAL WORKS

Rack & Pinion type elevator inside of chimney shell.





4.04.00 OTHER REQUIREMENTS

Scope of work include obtaining necessary approvals, materials, execution as per Codes, specifications, best engineering practices and to the satisfaction of the Owner for all Civil/Structural, Mechanical and Electrical, C & I works.

Bidder shall visit and appraise himself fully with the existing site conditions including soil conditions, rainfall data and availability and transportation of all construction materials including backfill, granular materials, etc and other aspects for construction of the work covered under this package.

5.0.0 TERMINAL POINTS

- Terminal point of flue shall be One (1.0) m away from chimney shell at about 45 m height for both the units. The transition piece (rectangular duct to circular) shall be in bidder's scope. (The exact height shall be confirmed after getting FGD vendor's confirmation during detail engineering).
- Bidder shall refer Sub-section-I of Section-III (Vol. IIB) for Electrical terminal points.

6.0.0 EXCLUSIONS

- Forced ventilation system including the air inlet duct for the chimney.
- Rain water Harvesting is excluded from the scope of Bidder.

7.0.0 FACILITIES TO BE PROVIDED BY THE OWNER

7.1.0 LAND

Land, free of charge as available with the Owner for the construction of:

- Temporary Residential colony to be built by the Successful Bidder at his own expense for his workers near site with sanitary and drinking water facility.
- Site office, pre-assembly/storage yard to be constructed at Successful Bidder's own expense within the plant site.

7.2.0 CONSTRUCTION WATER & POWER

Construction water at one (1) point shall be made available free of cost and power supply at one (1) point at 11 KV AC $\pm$ 10%, 3 Ph, 50 Hz. $\pm$ 5% near the erection site shall be made available with meter; cost of





electricity will be charged at prevailing rate. Any other voltage, if required for any operation during construction, shall be arranged by the Successful Bidder from above source of Power supply. No separate drinking water supply shall be given.

8.0.0 DRGS / DOCUMENTS TO BE FURNISHED BY BIDDER ALONG WITH BID

All the sub-vendors should have the Qualifying Requirements as detailed in "Volume- I: Conditions of Contract" for Chimney Package.

- Write-up, description and illustrative drawings for the piling work to be carried out including name of sub vendor if any.
- Write-up, description and illustrative pamphlets of Aviation obstruction lighting system along with the control panel including name of supplier.
- Write-up, description and illustrative pamphlets of rack and pinion stack elevator including name of supplier.
- Write-up, description and illustrative pamphlets of insulation materials to be used including name of supplier
- Write-up, description and illustrative pamphlets of load bearing insulation and restraint blocks including name of supplier
- Write-up, description and illustrative pamphlets of expansion compensators including name of supplier
- Procedure of construction with a list of construction equipment proposed to be deployed.
- Write-up, description and illustrative pamphlets of elevator for slip/ jump/ climb form.
- Description and illustrative pamphlets of slip/jump/climb form shuttering system proposed to be deployed.
- Write-up, description and illustrative drawings for the Electrical erection work earthing work, lightening system etc. to be carried out including name of sub vendor if any.
- Write-up, description and illustrative drawings for the Electrical Main Panel, Emergency Panel and other Panel work to be carried out including name of sub vendor/ Manufacturer, if any.

9.0.0 DRGS/DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1.0 CIVIL WORKS

- Detail working drawings for construction, erection marking drawings



and sectional assembly drawings, detailed literature of materials of construction.

- Bar Bending Schedule of all concrete structures.
- Piling driving records and pile load test results.
- Fabrication drawings for all structural steelwork.
- Insert Details, Anchor bolt details
- Other drawings and data as necessary

Report of shop tests and test certificates of materials and performance test certificates.

- Manufacturing Quality Plans of all the systems & sub-systems.
- Field Quality Plans of all the systems & sub-systems.
- As-Built Drawings.

9.2.0 CHIMNEY ELEVATOR

- Technical Schedules.
- General arrangement, Layout drawing and section.
- Foundation plan, Loading & fixing details.
- Complete Electrical Control, Schematic wiring diagram.
- Write-up explaining the sequence of operation of control circuits/safety features.
- Reports on shop tests and test certificates.
- Bill of materials.
- Detailed erection and commissioning procedures.
- Test procedures.
- Routine test, type test, Acceptance test certificates.
- Manufacturing Quality Plan.
- Painting and Surface preparation procedure.
- Field Quality Plan.



- Operation and Maintenance Manual.
- As-Built drawings.

9.3.0 ELECTRICAL WORKS

Bidder shall refer Sub-section –I of Section-III (Vol. IIB) for “list of drawings” to be submitted.

10.0.0 LAYOUT

The Successful Bidder shall carryout the setting out of piles, foundation and structures and provides levels, with reference to general existing grid and Bench Mark. If the Successful Bidder uses the grid, benchmarks and reference pillars made by other package contractors, he shall co-ordinate with the contractors 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 benchmark, which has been followed by other agencies at the instruction of the Engineer. In case any discrepancy is found, it should be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint will be entertained at a later stage. The Successful Bidder shall accurately set out the positions for holding down bolts and inserts as applicable.

If required, in the option of the Engineer, the bidder shall construct pillars for grid, references and benchmarks and maintain them till completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layout and levels. The Successful Bidder shall be solely responsible for the correctness of the layout and levels. The Bidder shall take into account the cost of these while quoting rates.

11.0.0 WORKMANSHIP

The Successful Bidder shall execute the work with such material and labour so that best standard of workmanship at all stages of construction is achieved, as aimed under this specification. The Successful Bidder shall engage skilled labour for all work except for those, which normally do not require skilled labour.

If the bye-laws of the local Government, Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Successful Bidder shall arrange to have the work done by such registered or licensed personnel. In case of manufactured items being used in the work, the Successful Bidder shall arrange to have at site, at his own cost, the services of the supervisors of respective manufacturers to ensure that the work is done in accordance with the specification and requirement.





12.0.0 TEMPORARY WORK

All scaffolding, staging, bracing and other necessary temporary work required for proper execution of the job shall be provided by the Successful Bidder at his own cost and rate shall be inclusive of providing of all materials, labour and supervision. The layout and details of such temporary work shall have prior approval of the Engineer; but the Successful Bidder 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 of other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or work of other agencies, such removal and re-erection if required, shall be carried out by the Successful Bidder, at the discretion of the Engineer without any delay and any extra cost on this account shall be borne by the Successful Bidder.

13.0.0 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the work is 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 Successful Bidder. 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 Successful Bidder shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing upto date progress on all-important items of work.

14.0.0 TIME OF COMPLETION

All works within the scope of this tender shall have to be completed within a period of **twenty-one (21) months** from the date of issue of work order. The construction at site must commence within two (2) weeks from the said date.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: IIA

SECTION-II

PROJECT MANAGEMENT AND SITE SERVICES



Development Consultants Pvt. Ltd.

**Vol. II-A/Section-II
Project Management & Site Services**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	PROJECTMANAGEMENTSERVICES	1
2.00.00	SITE SERVICES	1





VOLUME: IIA

SECTION-II

PROJECT MANAGEMENT AND SITE SERVICES

1.0.0 PROJECT MANAGEMENT SERVICES

1.1.0 RESPONSIBILITY

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this Contract. Responsibilities of this project Management team shall cover the areas listed below:

- a) Planning and Monitoring
- b) Engineering Management
- c) Contracts Management
- d) Quality Assurance, Inspection & Expediting
- e) Construction Management
- f) Spares Management
- g) Commissioning Management

Detailed responsibilities in the above areas are discussed below:

1.2.0 ORGANISATION

1.2.1 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager, who shall be responsible to Owner for the execution of the project.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.1.0, who, in turn, will report to the Project Manager for all matters relative to this contract.

1.2.2 Central Co-ordination Cell

The central coordination cell shall preferably be based in Tuticorin and shall have sufficient technical personnel to coordinate technical matters and to quickly



resolve day to day queries or references made by the Owner and his Consultants without having the need to refer to his headquarters each time.

1.2.3 Site Organisation

The site should have a competent construction manager for all site operations with sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.

1.2.4 Organisation Chart

The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.1.0 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation. Organisation chart shall be furnished as per the form duly filled as mentioned in GCC.

1.3.0 Implementation schedule

The schedule for the completion of the new 150 m high Twin Flue RCC Chimney for their existing 2 x 500 MW Power plant of NLC Tamil Nadu Power Ltd. Would be as follows :

Sl. No.	Item of Work	Period in Months from Zero date (Taken from the date of issue of Letter of Award)
	a. Test Piles & Load test	2
	b. Piling	5
	c. Pile Cap	7
	d. Shell Construction	14
	e. Platforms, Flue Erection & Insulation	18
	f. Elevator Erection, Aviation Lighting & Commissioning	21

To achieve these overall targets, the Contractor shall furnish to the Owner, various schedules as defined below:

1.3.1 Engineering Schedules

These schedules shall cover various submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every sub-systems/ items of work covered in the scope of this specification.

1.3.2 Manufacturing Schedule

The Contractor shall submit to the Engineer his manufacturing and delivery schedules for the equipment within thirty (30) days from the date of issue of the Letter of Award (LOA). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.3.3 Construction & Erection Schedules

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering construction and erection sequence, testing and commissioning activities. These schedules may be based on the recommended construction and erection procedures and will be subject to discussions/ agreements with the Owner subsequent to the award of contract.

1.3.4 The successful Bidder shall have to provide all the above schedules (i.e. 1.3.1, 1. 3.2 & 1.3.3) in a tabular form in addition to that in the form of network and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.3.5 The Contractor shall provide the Owner the original floppy/disc/software for all such schedules along with requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software.

1.4.0 DETAILED RESPONSIBILITIES

1.4.1 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network consisting a more detailed break-up of activities.

The network shall be prepared on a Work Breakdown Structure for the work package which sub-divides the work into a set of specific systems/ sub-systems. The master network will identify milestones of key events for

each system in the areas of procurement, testing, construction, fabrication, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Successful Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and construction activities. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones including gap analysis and remedial measures.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed status of engineering submissions, quality plan submissions and approval, procurement, manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones. including gap analysis and remedial measures.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) This report would also cover the areas pertaining to the receipt of the construction materials, equipment, transport, receipt at site, erection and commissioning.

- vi) This report would also cover the areas pertaining to the construction activities at site and progress achieved, cumulative and during the reporting period.

In addition to the above, as the Contract execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of E-Mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.4.2 Quality Assurance, Inspection and Expediting

The Contractor shall obtain approval of the list of sub-vendors from whom the equipment/materials are expected to be procured and the quality assurance plans thereof for the manufacture which shall need approval by the QA group of Owner before the manufacture is commenced. The prospective list of suppliers may be submitted along with the bid for approval by the Owner at the time of award of contract. On the approved quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.4.1 above. Despatch of fabricated materials, equipment & materials shall be sequential matching erection activities as well as schedule.

1.4.3 Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Award the Contract, the Contractor shall submit a programme of construction/ erection/ commissioning, either in continuation with the fabrication, manufacture and despatch or separately for the implementation. These programmes would be amplified showing when the civil drawings shall be required by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring.

The L-3 programme would be jointly finalised by the site-in-charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

1.5.0 PROJECT PROGRESS REVIEW MEETINGS

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution in respect of this new Chimney package for existing 2 x 500 MW thermal Power plant of NLC Tamil Nadu Power Ltd. will be held at least once in one (1) month at site or in the country of the Contractor depending on the circumstances and mutual agreement. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings at site between the Contractor and the Owner will be decided upon as part of erection coordination procedure.

1.6.0 OWNER'S CONSULTANT

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.1.0 above. The details of interaction and procedures for coordination between Owner/Owner's Consultant and Contractor/Contractor's project management team shall be finalised during contract negotiations.

2.0.0 SITE SERVICES

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

- 2.1.0 Arranging procurement of construction material, dispatch from the fabrication yard.
- 2.1.1 Deployment of all skilled and unskilled manpower required for construction, fabrication, erection, supervision of erection, watch & ward, commissioning and other services to be rendered under this specification.
- 2.1.2 Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
- 2.1.3 Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, lubricant, chemicals etc. as well as materials required for temporary



supports, scaffolding etc. as necessary for such erection work except those listed under exclusion elsewhere in this specification.

- 2.1.4 Construction of all civil/structural/architectural works, including construction of foundation as required, grouting, and all other incidental civil activities as detailed elsewhere.
- 2.1.5 All structural steel fabrication and erection work as detailed elsewhere in the specification.
- 2.1.6 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
- 2.1.7 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Factory Inspector, Electrical Inspector etc. for respective portions of work under the jurisdiction of such statutes or laws.
- 2.1.8 The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in this regard.

2.2.0 SITE ORGANISATION

The Contractor shall maintain, a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.3.0 GENERAL GUIDELINES FOR FIELD ACTIVITIES

2.3.1 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.3.2 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

2.3.3 The Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.3.4 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

2.3.5 The Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

2.3.6 The works under execution shall be open to inspection & supervision by the Owner's engineer at all times. The Contractor shall give reasonable notice to

the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.

- 2.3.7 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.3.8 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.3.9 All the works such as cleaning, checking, levelling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipment for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.3.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Engineer.
- 2.3.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Engineer, will have to be done by the Contractor without any cost implication to the owner.
- 2.3.12 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Engineer, with all the necessary tools & tackles, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.3.13 Additional platforms for approaching different levels as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.



2.3.14 It shall be the responsibility of the Contractor to provide ladders for initial works till such time stairways are completed. For this, the ladder should not be welded and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.

2.3.15 Structural materials required for the supporting/operating platforms required at various levels will be arranged by the Contractor.

2.4.0 SAFETY

2.4.1 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.

2.4.2 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.

2.4.3 Storage of petroleum products for construction work shall be as per rules and regulation laid down in Petroleum Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from statutory authorities shall be the responsibility of the Contractor.

2.4.4 The Contractor shall be responsible for safe storage of his and his sub-contractors radioactive sources if any.

2.4.5 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be periodically done by the Contractor. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.

2.4.6 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, and fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 2.4.7 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.
- 2.4.8 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.4.9 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.4.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.4.11 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.4.12 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME : II-A

SECTION - III

ENGINEERING SERVICES



Development Consultants Pvt. Ltd.

**Vol. II-A/Section-III
Engineering Services**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GENERAL	1
2.00.00	DESIGN COORDINATION MEETING	1
3.00.00	CO-OPERATION WITH OTHER SUCCESSFUL BIDDERS AND CONSULTANTS	1
4.00.00	GUIDELINES FOR OWNER'S ENGINEERING SERVICES	2
5.00.00	INSTRUCTION MANUALS	4
6.00.00	PLANT HANDBOOK FOR CHIMNEY PACKAGE	5
7.00.00	TENDER STAGE DOCUMENT SUBMISSION	5
8.00.00	CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE	6
ANNEXURE-1	FINALISATION OF SUBVENDOR	9





VOLUME : II-A

SECTION-III

ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Successful Bidder shall be responsible for proper Owner's Engineering and co-ordination of activities during various phases of execution of the contract. The Successful Bidder shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Owner's Engineer or the Review Consultant shall interact on matters related to Owner's Engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Successful Bidder and shall be responsible for all Owner's Engineering co-ordination. The Owner /Consultant /Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Successful Bidder or on matters involving the Successful Bidder, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the Successful Bidders. However such interaction will not, under any circumstance, dilute the responsibility of the Successful Bidder to provide a fully Owner's Engineered and coordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of Owner's Engineering information will be mutually agreed and finalized between the Owner and the Successful Bidder.

2.00.00 DESIGN COORDINATION MEETING

The Successful Bidder and his sub-vendors will be called upon to attend design co-ordination meetings with the Owner's Engineer, other Successful Bidders and the Consultants of the Owner during the period of execution of contract. The Successful Bidder including his sub-vendors shall attend such meetings at their own cost at Owner's office in Tuticorin or Consultant's office in Kolkata/ or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 CO-OPERATION WITH OTHER BIDDERS AND CONSULTING OWNER'S ENGINEERS

The Successful Bidder shall agree to cooperate with the Owner's other Bidders and Consulting Owner's Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all correspondences

addressed by the Successful Bidder to other Sub- Vendors and Consulting Owner's Engineers in respect of such exchange of technical information.

4.00.00 GUIDELINES FOR OWNER'S ENGINEERING SERVICES

- 4.01.00 Prior to commencement of the Owner's Engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed Owner's Engineering work.
- 4.02.00 Owner's Engineering work shall be performed on modern and proven concepts and internationally accepted good Owner's Engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the Owner's Engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Successful Bidder.
- 4.03.00 At any stage during the performance of assignment, the Successful Bidder may be required to make certain changes/modification/improvements in design/drawing/other documents, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the Chimney package and its systems/sub-systems/components in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution/operation of similar units. Such changes/ modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and Scope of the Successful Bidder.
- 4.04.00 During the course of review of detailed Owner's Engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.
- 4.05.00 During the course of review of detailed Owner's Engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants Owner's Engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.
- 4.06.00 It is not the intent to give details of every single task covered in the total Owner's Engineering work to be carried out by Successful Bidder, however, all Owner's Engineering work required for the satisfactory completion of the Chimney Package as specified shall be carried out by the Successful Bidder. Broadly, the following are the minimum requirements in respect of scope of major items of work:
- 4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned drawings (Chimney GA- detailed



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

plan, elevation and cross-sectional drawings at different elevations/ floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities.

Drawings and Schedules prepared by the Successful Bidder from time to time, as detailed designs are developed, shall be submitted for Owner's/ Consultant's approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

- 4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-Vendors.
- 4.06.03 Review of sub-Vendor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.
- 4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments, etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.
- 4.06.05 Not used.
- 4.06.06 Preparation of consolidated schedules and bills of materials, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the Chimney package including dampers, ducting etc.
- 4.06.07 Not used.
- 4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.
- 4.06.09 Certification and submission of final as-built drawings for all areas.
- 4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.
- 4.06.11 All erection and assembly drawings which may be required at site.



5.00.00 **INSTRUCTION MANUALS**

5.01.00 The Bidder shall provide all necessary instruction manuals for the Owner's review, comment, and final acceptance as required in the contract. The instruction manual shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies.

5.02.00 **Erection Manuals**

5.02.01 The erection manuals shall be submitted at least three (3) months prior to commencement of erection activities of particular equipment/system. The manuals shall contain the following as a minimum:

- a) Erection strategy.
- b) Sequence of erection.
- c) List of tools, tackles, heavy equipments like cranes, dozers etc required for erection.
- d) Bill of Materials.
- e) Safety precautions to be followed during erection.
- f) Erection instructions.
- g) Critical checks and permissible deviation/tolerances.
- h) Check-list for pre-commissioning activities
- i) Check-list for commissioning of the system.
- j) Procedure for initial checking, testing and acceptance norms.

5.03.00 **Operation & Maintenance Manuals**

5.03.01 The operating and maintenance instructions together with drawings of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble, and adjust all parts of the equipment. They shall outline a step-by-step procedure for all operations likely to be carried out for Chimney package. Each manual shall include a complete set of drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.

5.03.02 If after commissioning and initial operation of the Chimney, the manuals require any modification/ additions in the view of the Owner or Bidder, the same shall be incorporated and the updated final manuals shall be submitted to the



Owner.

5.03.03 The manuals shall include the following:

- a) List of spare parts along with their drawing and catalogue and Pro-forma for ordering spares.
- b) Location and identification guide for bearings of various equipments and lubrication schedule including charts showing lubrication checking, testing and replacement procedure.
- c) Wherever applicable, fault location charts shall be included to facilitate fault detection.
- d) Detailed specification for all consumables (including lubricating oils, greases, chemicals etc.) required for each equipment.

6.00.00 PLANT HANDBOOK FOR CHIMNEY PACKAGE

The Bidder shall provide the plant handbook for Chimney Package to the Owner as per provision of the contract.

The Plant Handbook shall contain the following as a minimum:

- a. Design and performance data
- b. Single line diagrams
- c. Sequence & Protection interlock schemes
- d. Alarm and trip values
- e. Performance curves
- f. General layout plan and layout of buildings
- g. Important Do's and Don'ts.

7.00.00 TENDER STAGE DOCUMENT SUBMISSION

7.01.00 The Bidder shall submit along with his bid all documents/drawings as specified in specification and respective sections of the Technical Specifications in Vol-II and Vol-III. The documents shall include but not be limited to the following:

- a) All Bid proposal sheets duly filled up.
- b) Detailed experience list and financial resources of the Prime Bidder his collaborators/associates in this bid as well as the sub-vendors proposed.



- c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.
- d) List of terminal points of the package offered together with quality and quantity of various input (i.e. steam, water, air, electricity etc.) as required from the Owner at such interfaces.
- e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.
- f) High level project schedule network indicating target dates for intermediate milestones and final commissioning of Chimney Package; This network shall be supplemented by a detailed write-up on proposed sequence and method of execution for project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.
- g) Sub-vendor List for the Equipment, as mentioned in Annexure-1, for approval by Owner/Consultant.

8.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

8.01.00 Owner's Engineering schedule shall be submitted by the Bidder as indicated in the specification. Owner's Engineering schedule shall be developed in format as desired by the Owner/consultant.

The documents shall be divided into two categories: a) for approval and b) for information/further Owner's Engineering and co-ordination by the Consultant.

In preparing this schedule, the Bidder shall allow one (1) week from date of receipt for review and comments by the Consultant for each submission of a document.

This document submission schedule shall require acceptance by the Owner/Consultant.

Bidder shall also develop and submit a Master drawing list to the Owner/consultant.

8.02.00 All contract documents shall be marked with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

8.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or

revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

8.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Consultant:

- b) Design basis documents / memoranda / calculations.
- c) Equipment data sheets and general arrangement drawings.
- d) Materials of construction.
- e) General Arrangement and Layout drawings.
- f) Typical control schemes, circuit diagrams, drive/ feeder-wise control scheme showing all external interfaces.
- g) Control System Configuration
- h) Shop Inspection and Testing Procedures, Test Set-up & Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- i) Performance Test Procedures, Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- j) Schedules covering equipment delivery schedules, erection, testing and commissioning schedules at L1 and L2 levels.

8.05.00 Unless specified otherwise, the following categories of documents / drawings would be treated for information/further Owner's Engineering by the Owner/Consultant. The Bidder shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/ Consultant.

- a) Equipment foundation drawings.
- b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
- c) Predicted performance curves of equipment.
- d) Various bills of quantity, schedules etc.
- e) Piping/flue fabrication drawings etc.
- f) Panel wiring diagrams.
- g) Instruction/Operation manuals.
- h) Service manuals and trouble shooting guide for C & I system including



field instruments.

- i) Operation logic diagrams.
- j) Cable schedule and interconnection chart.

In essence, the Bidder is solely responsible for corrections and adequacy of design & Owner's Engineering for documents under this category.

8.06.00 Upon review, the Consultant shall put his remarks and one of the following action stamps on the drawing / document:

- 1) Approved.
- 2) Approved as noted, resubmission required.
- 3) Commented, resubmission required.
- 4) For information/reference only.

For action stamps in category (2) & (3), documents must be resubmitted for review by the Owner/Consultant.

Except for action stamp under category (3), the Bidder can proceed with manufacturing and other sequential activities for those areas of a drawing/document. .

The Consultant may accord approval in category (2) or (3) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Bidder shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Bidder's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Consultant.

8.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

8.08.00 For review by the Consultant, the Bidder shall furnish three (3) prints of each drawing (only for first submission). There upon all transaction of drawings including reviewed comments and stamping shall be done in soft. All transaction of drawings shall be accompanied by a reference letter mentioning the date, revision no. and document status. Only on receiving the Approval Stamping, bidder shall distribute 6 sets of drawings (2 at NTPL corporate office and 4 sets at NTPL site office). The Bidder shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

8.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the more stringent stipulations shall prevail.

ANNEXURE-1

FINALIZATION OF SUB VENDORS

General

- a. The successful Bidder is responsible for performance/guarantee of the complete package including bought out items and out sourced processes. The Bidder will supply the equipment/component/system from the Purchaser/Consultant approved sub vendors only.
- b. The Bidder has to necessarily indicate in their bid, their proposed sub vendors for the items listed below. Sufficient number of sub vendors may be proposed to meet their need.
- c. The proposed list of sub vendors furnished by the Bidder will be reviewed during Techno Commercial/Pre-award discussions by Purchaser/Consultant and the sub vendors will be categorized as below.
 - i. **Category – I: Sub vendors accepted.** The acceptance will be based on past experience of Purchaser/Consultant.
 - ii. **Category – II: Sub vendors enlisted for future acceptance.** Such acceptance will be based on the various details regarding capacity, capability, experience etc of the sub-vendor proposed by the successful Bidder. It is the responsibility of the successful Bidder to get the details of the sub vendors under category II, compiled and submitted to Purchaser/consultant for scrutiny and acceptance. The acceptance criteria are mentioned below. However, Purchaser reserves the right to accept or reject any of the proposed vendors based on information available with them.
- d. The consolidated list of sub vendors under category I and category II will be made available to all the qualified Bidders before price cover opening.
- e. Purchaser may consider the Bidder's proposal for inclusion of new sub vendors, if any during post award stage for approval, based on merits, in the overall interest of the Package, after establishing that the sub vendors proposed meet the acceptance criteria specified. However, price advantage if any, arising out of inclusion of new sub vendors will be passed on to the Purchaser.
- f. Subsequent to approval of main sub vendor for main system after verifying the acceptance criteria, the main sub vendor will be allowed to choose his sub vendors for the sub system provided they meet the technical stipulation as per the contract requirements.
- g. For all other components/equipments/systems which are not figuring in the following list or in the additional list furnished by the Bidder in their bid, Bidder's standard practice of selection of vendors may be carried out.
- h. The items listed are not exhaustive. Hence if considered necessary the Bidder can include additional items and indicate their proposed sub vendors for those items also.

Acceptance Criteria for Sub Vendors:

**i) For all Mechanical, Electrical, Control and Instrumentation
(Except for items mentioned under ii and iii below)**

For Class I Items:

Bidder to furnish documentary evidence to show that similar or higher capacity component/equipment / system has been supplied by the vendor or their associate/collaborator and the same has been operating satisfactorily for two years. The documentary evidence will be in the form of Performance certificates furnished by the end user.

For Class II Items:

Bidder to furnish documentary evidence to show that similar or higher capacity component/equipment / system has been supplied by the vendor. The documentary evidence will be in the form of Material Receipt Certificate or Site Inspection Report, etc from the end user for having received the material by the end user.

The component/equipment / system covered under Class I and Class II are furnished below for Mechanical, Electrical, Control and Instrumentation.

ii) C & I items –Nil

iii) For all civil items

- (a) It should conform to relevant Indian/international Standards.
- (b) It should be of reputed makes supplied to similar construction / infrastructure projects.
- (c) The Bidder should furnish documentary evidence to prove (a) and (b) above

iv) For Cement:

- (a) It should conform to relevant Indian /International Standards.
- (b) It should be of reputed makes supplied to similar construction/infrastructure projects.
- (c) For Cement, minimum quantity of supply shall be 2500 MT for single project. The Supply Order and documentary evidence in the form of material receipt certificate or site inspection report from the end user for having received the material by the end user, shall be produced as documentary evidence.
- (d) The Bidder should furnish documentary evidence to prove (a), (b) and (c) above.

v) For reinforcement steel:

- (a) The quality shall conform to Indian Standard/International Standards.
- (b) The Firm should have been in the market for a minimum period of 3 years as on the original date of Tender opening and should have supplied & used the reinforced steel in any industrial project.
- (c) For reinforcement steel- minimum quantity of supply & used shall be 1000MT for a single project. The Supply Order and documentary evidence in the form of material receipt certificate or site inspection report from the end user for having received the material by the end user shall be produced as documentary evidence.
- (d) The Bidder should furnish documentary evidence to prove (a) (b) and (c) above

vi) For Structural steel (for use in civil & structural buildings only):

- (a) The quality shall conform to relevant Indian Standard/International standards.
- (b) The firm should have been in the market for a minimum period of 3 years as on the original date of tender opening and should have supplied & used the structural steel in any industrial project.
- (c) For Structural steel- minimum quantity of supply & used shall be 1000 MT for a single project. The Supply Order and documentary evidence in the form of material receipt certificate or site inspection report from the end user for having received the material by the end user shall be produced as documentary evidence.
- (d) The Bidder should furnish documentary evidence to prove (a), (b) and (c) above.

vii) For supply of Borosilicate Glass Blocks with primer and adhesive (Termed as Borosilicate block lining system) - (For use in the application inside the steel flue can)

- (a) The Firm should be a manufacturer of Borosilicate Lining System or authorised supplier of the manufacturer (OEM) and should have supplied, erected/ supervised erection of Borosilicate Block Chimney Lining system for at least one (1) number of RCC chimney of minimum 150 Meters height with steel flue can in a power plant.
- (b) The above Borosilicate block Chimney Lining system should have



completed satisfactory operation for a period of not less than one (1) year as on the original scheduled date of Tender opening.

- (c) The Bidder should furnish documentary evidence to prove (a) & (b) above by furnishing the following documents:
- Bidder shall furnish the PO copy / supporting documents of at least one (1) executed Contract as mentioned in 'a' above.
 - Corresponding certificate from owner for successful operation of 'borosilicate Glass block lining system' as mentioned in 'b' above indicating date of commissioning.

NOTE:

During the application of the Borosilicate Lining system, the sub vendor who is supplying the Borosilicate Lining system shall also supply sufficient number of skilled supervisors to assist the Application of the Borosilicate Lining system by the successful bidder. A separate QA plan towards this shall be furnished before starting of the works by the sub vendor for the approval of the owner.

ACCEPTANCE CRITERIA FOR SUB CONTRACTORS

i) For Mechanical and Electrical works:

Contractor to furnish documentary evidence to prove that similar mechanical / electrical erection and installation work had been carried out by the Sub contractor.

ii) For Civil & Structural works:

All Civil and Structural works related to Chimney, shall be carried out by the successful bidder as per QR requirements by which the successful bidder got qualified.

iii) Agency for conducting the Wet stack flow model Study:

A. The sub-contractor should have carried out one (1) No. wet stack flow model study along with design of the condensate collection system for the wet stack installed after wet limestone based FGD absorber in a coal/lignite fired power plant, which is in successful operation for a period of at least one (1) year as on the original scheduled date of Tender opening.

The bidder shall furnish the following supporting documents for approval of Wet stack flow model study agency:

- a. Bidder shall furnish the PO copy/ study reports of at least one

executed contract as mentioned in 'A' above.

- b. Owner performance feedback certificates for executed wet stack flow model study for the reference project as in (A), which has been successfully in use for at least one year as on the original scheduled date of Tender opening indicating the project name, date of issue of certificate and name/ designation of the certificate issuer.

However the final approval of the sub contractor for conducting the wet stack flow model study lies with the NLC / NTPL. The successful bidder shall place the order on this firm only after getting the consent / approval from NLC / NTPL to hire the services of the wet stack flow model study agency.

LIST OF EQUIPMENTS – Mechanical

- i) **Class I items: Items for which Performance certificates shall be furnished for approval of Category II sub vendors during detail engineering**

(a) Technological Items

Sl.No	Item Description	Sub Vendors
1.	Flue COR-TEN B	
2.	Flue Top 10m SS316 or BS 1449	
3.	Stack Elevator	

(b) Air Conditioning & Ventilation System

Sl. No	Item Description	Sub Vendors
1.	Air Conditioning System	
2.	Ventilation System	

- ii) **Class II items: The documentary evidence for approval of Category II sub vendors shall be in the form of Material Receipt Certificate or Site Inspection Report, etc from the end user for having received the material by the end user.**

(a) Technological Items

Sl. No	Item Description	Sub Vendors
1.	Welding electrodes	

LIST OF EQUIPMENTS –Electrical

Class I items:

Sl. No	Item Description	Sub Vendors
1.	Auxiliary Relays	
2.	Electro Mechanical Relays	
3.	L.T. Motors (AC & DC)	
4.	Lighting Transformer	
5.	LT Control Cables	
6.	LT Power Cables(XLPE)	
7.	LT Trailing Cables	
8.	Numerical protection Relays	
9.	MLDB/PDB/ACD/WDB/ELDB / DCDB / LCP / LPBS / DCLDB	
10.	UPS	

Class II items:

Sl. No	Item Description	Sub Vendors
1.	AC/DC Control Contactors	
2.	AC/DC Power Contactors	
3.	Cable Glands	
4.	Cable Lugs	
5.	Cable Termination & Jointing Kits	
6.	Cable Trays	
7.	Control Transformers	
8.	Current Measuring Modules	
9.	Energy Meters/Multi Function Meters	
10.	High Mast	
11.	LED Lighting	
12.	Lighting Fixtures (Flame Proof)	
13.	Lighting Fixtures (General)	
14.	MCCB/MPCB/MCB	
15.	Meters (Analog/Digital)	
16.	Street Light Poles	
17.	Transducer	

LIST OF EQUIPMENTS – CONTROL & INSTRUMENTATION

Class – I items: Nil

Class II items: Nil

LIST OF EQUIPMENTS – Civil & Structural Supply Portion

a. Building Materials



Sl. No	Item Description	Sub Vendors
1.	Steel doors, windows and ventilators / Pressed door, including accessories	
2.	Aluminium doors, windows, partitions and grill	
3.	FRP Doors including all accessories	
4.	Water proofing compounds	
5.	Interior Emulsion paint	
6.	Synthetic paint	
7.	Painting over steel work	
8.	Metallic Floor Hardener	
9.	Non-skid fully vitrified tiles	
10.	Water proof cement paints and exterior emulsion paints	
11.	Borosilicate blocks, adhesive and Primer	

b. Sanitary and Water Supply Work

Sl. No	Item Description	Sub Vendors
1.	W.C. Pan Wash Basin, Urinals Sink Low down flushing Cistern & EWC	
2.	Colour/White Glazed Tiles, Heavy Duty Ceramic tiles and Vitrified Tiles.	
3.	HDPE Water tank	
4.	DI Pipes	

c. RCC Items

Sl. No	Item Description	Sub Vendors
1.	Cement	
2.	Reinforcement Steel	

d. Structural Steel

Sl. No	Item Description	Sub Vendors



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Sl. No	Item Description	Sub Vendors
1.	Structural Steel	

Category – I: Sub vendors accepted. Bidder will select the vendors of Category I without any approval of Purchaser/Consultant (Only for Civil Items)





**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

DOMESTIC COMPETITIVE BIDDING

Tender No: COCONTS/ 0010 K/RT/NTPL/Addl. Chimney /2020, Dt. 01.07.2020.

Date & Time of Opening: 04.08.2020 at 15.00 Hrs. (IST)

TENDER SPECIFICATION

for

**Construction of One RCC Additional Chimney of 150 M height with
Borosilicate lined Bi-flue can arrangement for Flue Gas Desulphurization
Plant of 2X500 MW Coal based Thermal Power Plant located at Tuticorin,
Tamil Nadu, India.**

VOLUME – II B SEC - I

PART - A: GENERAL TECHNICAL SPECIFICATION FOR CIVIL AND STRUCTURAL WORKS

PART - B: CIVIL SPECIFICATION FOR CHIMNEY STRUCTURES

PART - C: SPECIFIC DESIGN REQUIREMENTS OF CIVIL



Development Consultants Pvt. Ltd.

July 2020



**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: I

**GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: I
Geotechnical Investigation**



**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	SOIL EXPLORATION	4
4.00.00	PENETRATION TESTS	10
5.00.00	GROUND WATER INVESTIGATION	12
6.00.00	FIELD TESTS	14
7.00.00	TESTS FOR DYNAMIC PROPERTIES	18
8.00.00	FIELD DETERMINATION OF CALIFORNIA BEARING RATIO	20
9.00.00	LABORATORY TESTS ON SOIL SAMPLES / ROCK CORES	21
10.00.00	REPORT ON SUB-SOIL INVESTIGATION	21





**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: I

**GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION**

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The successful bidder shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, successful bidder's office, stores and protection of adjacent buildings, structures or services / facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his bid. The boreholes shall be selected such that all the founding structures including RCC roads and Concrete pavements are represented.

2.01.00 Work to be provided for the successful bidder

The work to be provided by the successful bidder, unless specified otherwise shall include but not be limited to the following.

- a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervisions by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the owner / engineer.
- b) Locate in the field and in layout drawing all boreholes and other field investigation items.





- c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.
- d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification and instructions of the owner / his engineer.

2.02.00 Work to be provided by others

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

2.03.00 Location and Levels

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the successful bidder at his own cost from two reference grids and one bench mark given by the owner/ his engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets / tables to be incorporated in the report by the successful bidder.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the successful bidder at no extra cost by the owner.

2.04.00 Codes and Standards

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498	-	Classification and identification of soils for General Engineering purposes.
IS:1888	-	Method of load tests on soils
IS:1892	-	Subsurface investigation for foundation
IS:1904	-	Structural safety of buildings : shallow foundations
IS:2131	-	Method for standard penetration test for soils
IS:2132	-	Code of Practice for thin walled tube sampling of soils
IS:2720	-	Methods of tests for soils
IS:2809	-	Glossary of terms and symbols relating to Soil Engineering.
IS:2810	-	Glossary of terms relating to soil dynamics



**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS:3025	-	Methods of sampling and testing for water used in industry
IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for insitu vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation
IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
IS:4968 (Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
IS:5529 (Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009 (Part-I)	-	Calculation of settlement of foundations - Shallow foundations subjected to symmetrical static vertical loads
(Part-II)	-	Deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands





IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils
IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge.

Various methods of boring as described in IS: 1892 may be adopted. The tenderer shall furnish the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. In case rock strata is

encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The successful bidder shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the successful bidder shall have no claim whatsoever on this score. If the successful bidder can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The successful bidder shall use his own materials for this and the scope shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the successful bidder using sand fill as and when directed by the Engineer.

3.02.00 **Stabilization of Boreholes**

Boreholes shall be stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.03.00 **Open Trial Pits**

The open trial pits shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The present formation level is finished plant level. Hence the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not



below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The successful bidder shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the engineer.

The successful bidder shall include the scope of trial pit with earthwork in excavation, necessary side slope, backfilling and shoring/ sheeting for side protection, if required.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.04.00 **NOT USED**

3.05.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall furnish the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock than by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be



of designation BX or NX.

During the drilling operation for each bore-hole the successful bidder shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the successful bidder shall determine nature of fractures and degree of weathering of rock for each bore hole. The successful bidder shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The successful bidder shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The successful bidder shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer. (All the field works shall be verified and signed by the Engineer (owner's) at site)

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the successful bidder shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

- a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).
- b) IS:4078 - Code of Practice for indexing and storage of drill cores.
- c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.06.00 Adits and Test shafts

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for insitu tests to determine the modulus of deformation of rock.

3.07.00 Sampling

Bored soil shall be collected continuously during boring to note any change of



strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring , since it is intended to ascertain the characteristics of the soil at various depths. If, however , there is fair uniformity in the characteristics of the soil for certain depths the engineer may limit the number of samples stipulated above.

3.07.01 Tube Sampling

For obtaining undisturbed samples in its simplest form , an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately one inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge or cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high , but not less than 50 mm dia. x 150 mm high.

Representative / disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.07.02 Chunk Samples

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall

be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.07.03 **Sampling in rock**

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.08.00 **Record of Boring**

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

- a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.
- b) Personnel information - name of drilling Bidder, driller and inspecting engineer.
- c) Equipment data - manufacturer's name and model designation.
- d) Sampling and coring information :
 - i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.
 - ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.
 - iii) Push samplers : hydraulic pressure and rate of penetration.
 - iv) Soil or rock coring : average rotational speed, down-ward

hydraulic pressure and rate of penetration.

- v) Rock coring : Rock quality designation (R Q D)
- e) Description of material penetrated but not sampled.
- f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.
- g) Seepage pressure test information-depth and duration of test.
- h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.
- l) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.
- j) Elevation of top and bottom of hole and top of rock
- k) Date and time of all operations and delays with reasons.
- l) Miscellaneous information to aid interpretation of sub-surface conditions.
- m) Additional pertinent information.
The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS: 2131 at every change in strata or at 1.5 m intervals or as directed by the engineer. The successful bidder shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Hammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetrating shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for

last 300 mm of penetration) at appropriate depths.

4.02.00 **Static Cone Penetration Test**

The test shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge.. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec approximately so as to advance the cone only to a depth which is possible with the cone assembly available.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The successful bidder shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 **Dynamic Cone Penetration Test**

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentonite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part – II, the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5 mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow



count for 300 mm penetration vs. depth.

5.00.00 GROUND WATER INVESTIGATION

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 Ground water level observation

The successful bidder shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the successful bidder during the period of investigation. At the end of the site investigation work, these boreholes shall be handed over to the owner in such a condition that further observations can be taken by the owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 In-Situ Permeability Test

In-situ permeability test shall be performed in the boreholes specified and/or at such other locations at specified depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The successful bidder shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 Pump - in Test

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be



used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of pre-bored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS: 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored / discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS: 2470-Part-I, Appendix-A.

5.02.02

Pump - Out Test

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water



level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 FIELD TESTS

In situ tests shall be performed as desired by the engineer to measure properties of soil during the field investigation work.

6.01.00 Menard Pressure meter test

This test shall be carried out as per clause 3.7 of IS:1892 in the bore holes specified and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The successful bidder will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The successful bidder shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 Direct Load Tests on Soils

The direct load tests on soil shall be carried out in the trial pits specified and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm square plate will be used in clayey soil and in sandy soils, three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of sub-grade reaction and deformation modulus of soil.

The excavation and side protection during the test and back- filling after the test shall be carried out by the successful bidder. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the successful bidder.

The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.



The successful bidder must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level and staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the successful bidder shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

Each test shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m shall also be considered by the bidder if the site condition warrants. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the successful bidder himself.

6.03.00

Vane Shear Tests

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon



the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 **Determination of Dry-Density of Soils**

In place dry density of soil is required for assessment of bearing capacity of soils analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the engineer for determination of in-place dry density of soils.

6.04.01 **Sand Replacement Method**

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS: 2720 (Part XXVIII).

6.04.02 **Core-cutter Method**

The specification for this test shall be as per IS:2720 (Part XXIX). The method should be applied for fine grained soil, free from aggregates. Fine grained soils for the purpose of application of this method is defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 **Ring and Water Replacement Method**

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic

film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 **Rubber balloon Method**

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV). This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 **In-situ Block Shear / Wedge Shear Test**

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The test in the trial pits shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

6.06.00 **Test for Measurement of soil Resistivity**

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing $S = 5, 10, 15, 20$ metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V , between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes, then the soil resistivity.

$$= 2 \times 3.14 \times S.V / I$$

Where, Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

= Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement, above formula becomes

$$= 2 \times 3.14 \times S.R.$$

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 of the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The locations at which such tests are to be carried out as indicated and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.

The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the successful bidder shall have to modify the



arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The scope shall include earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 **Block Vibration Test**

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

- a) Vertical Vibration Test
- b) Longitudinal Horizontal Vibration Test
- c) Free Vertical Vibration Test
- d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS: 1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The successful bidder must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick



replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

The successful bidder shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the successful bidder shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the successful bidder shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

The test shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The test shall be carried out at a depth of 500 mm below the finished ground level.

The successful bidder shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down in IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the



bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES / ROCK CORES

The successful bidder shall carry out the tests as listed out as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The owner shall have the right of access to successful bidder's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labelled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

10.01.00 General

- a) On completion of all the field (all the field works shall be certified by the owner) and laboratory work, the successful bidder shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the successful bidder shall submit ----- copies of the report in draft form for the owner's review.
- b) The successful bidder's qualified geotechnical engineer shall visit the owner's corporate office for a detailed discussion on the owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft



report. Thereafter the successful bidder shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducibles of the graphs, tables, etc.

- c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The successful bidder shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 Data to be furnished

The report shall include the enlisted items but not be limited to them.

- a) Purpose and scope of investigation
- b) Authorization enabling the successful bidder to carry out the work at the site.
- c) Project description including proposed facilities and construction materials required for the works.
- d) Description of the site which shall include :
 - i) Location of the site and existing facilities.
 - ii) Topography of the site
 - iii) Drainage Characteristics
- e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.
- f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.
- g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.
- h) Geological information
 - i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.





**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- ii) Description of overburden and bedrock at the site (if applicable for the site)
- iii) Comments on texture and structure of rock, joints, bedding planes, fissures, weathering condition etc (of applicable for the site)
- iv) Effect of geologic features on design.
- i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.
- j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.
- k) Plot of SPT (N) value (both uncorrected and corrected) with depth.
- l) Procedure of investigations employed - field tests and laboratory investigation.
- m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.
- n) For all triaxial shear tests stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity E shall be furnished for all tests along with relevant calculations.
- o) For all consolidation tests, the following curves shall be furnished :
e vs. log p
e vs. p and
compression vs. log t or
Compression vs. square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.
- p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.
- q) For pressure meter tests, the following curves shall be furnished :





Field pressure meter, creep and air calibration curves indicating P_o , P_f and P_1 .

Corrected pressure meter and creep curves indicating P'_o , P'_f & P'_1 .

- r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 Recommendations

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following:

- a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.
- b) If required for shallow foundations, the following shall be indicated with comprehensive supporting calculations:
- i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.
 - ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.
 - iii) Rate and magnitude of settlement expected of the structure.
 - iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results along with time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.
- c) As piling is envisaged, the following shall be indicated with comprehensive supporting calculations:



- i) Type of pile and reasons for recommending the same considering soil characteristics.
 - ii) Suitable founding strata for pile.
 - iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.
 - iv) Magnitude of negative skin friction, if any, to be considered in pile design.
- d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.
- e) Recommendations regarding bases of roads and pavements.

10.04.00 Additional Recommendations

- a) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.
- b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.
- c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.
- d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.
- e) Co-efficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.
- f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.
- g) Recommendations regarding method and slope of deep excavations.
- h) Recommendations regarding stability of slopes, during excavations, etc.
- i) Potential of rock slides and methods of stabilisation of sides for very steep cut.

- j) If expansive soil is met with recommendation on removal or detainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.
- k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.
- l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.
- m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub- structures and also recommended protective measures, if required.
- n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.
- o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits / trenches.
- p) Recommendation on the use of rock available as construction material.
- q) Recommendation on the availability of material for use as aggregates at the site.
- r) Recommendation for additional investigation beyond the scope of the present work if the successful bidder considers it necessary.
- s) **Plates**
 - i) General plan showing location of site, and areal geology.
 - ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
 - iii) Geologic sections and soil profiles.
- t) **Appendices**
 - i) Logs of subsurface explorations
 - ii) Field test results
 - iii) Laboratory test results



Tender Specification
for
Chimney

NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: II

**GUIDELINE
FOR
AREA GRADING**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: II
Area Grading



**Tender Specification
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Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	EXECUTION	4
4.00.00	TESTING AND ACCEPTANCE CRITERIA	12
5.00.00	INFORMATION TO BE SUBMITTED	13





**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: II

**GUIDELINE
FOR
AREA GRADING**

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, , hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for sub-grade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof.

Since the work is to be carried out within the existing plant premises, dismantling of any existing structures as instructed by the owner, clearing and disposal of debris outside the plant premises and stacking the useful materials within the plant boundary in locations as directed by the owner included in this scope. Also care shall be taken, activities of this project shall not affect the nearby structures of the existing plant and necessary protection mechanism may be done if warranted by the successful bidder without any price implication to the owner.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful bidder

Generally the area is graded since it is within the existing plant. However if Necessary site leveling & Area Grading works of the Chimney package area including final micro leveling and dismantling of any paving is to be done by the successful Bidder.

The work to be provided for by the Successful bidder, unless specified otherwise, shall include but not be limited to the followings:

- a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.





- b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.
- c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place,
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils,
IS : 3764	:	Safety Code for Excavation Work





- IS : 4081 : Blasting and related drilling operations
- IRC : SP-11 : Hand book of quality control for construction of roads and runways
- IRC : 36 : Construction of Earth Embankments for Road Work

2.04.00 **Conformity with Designs**

The Successful bidder shall carry out the work as per the drawings issued to him and/or Successful bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

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

2.05.02 Borrow Material(If required)

Borrow material if required for area filling shall be excavated from approved locations shown within 25KM and levels, and shall consist of selected material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage.

Necessary arrangement shall be done by the Successful Bidder for locating and using the borrow areas after approval as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 Quality Control

The Successful Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

- a) Lines, Levels and Grades: i) Periodic Surveys





- ii) Establishment of markers, Boards etc.
 - iii) Checking levels and slopes of the graded surface.
- b) Area filling :
 - i) Checking the quality of fill material
 - ii) Checking moisture content of the fill.
 - iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications shall be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection shall be reviewed in accordance with the site Quality Plan.

3.00.00 EXECUTION

3.01.00 General

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, cable, pipelines, drains, trenches, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the SuccessfulBidder. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Owner. Adequate area lighting shall be provided by the SuccessfulBidder, if night work is undertaken.

The SuccessfulBidder shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Owner. The proposal shall include but not be limited to the following.

- a) Mobilization and demobilization of plant
- b) Proposed plant and equipment, labour resources & supervision.



- c) Details of proposed method of clearing and grubbing for each area of cut and fill.
- d) Drawings showing the areas for placement of material.
- e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.
- f) Temporary works proposals
- g) Excavation, filling and compaction by mechanical plant
- h) Dealing with surface water
- i) Dewatering
- j) Disposal of materials
- k) Safety precautions, fencing and lighting
- l) Calculations as appropriate to support work proposal

3.02.00 Setting Out

The Successful Bidders shall prepare and submit to the Owner/Consultant, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Owner/Consultant with modifications and corrections if necessary, the Successful Bidders shall set out the work from the control points furnished by the Owner and fix permanent points and markers for future checking. These permanent points and markers shall be checked by the Owner and certified by him after which the Successful Bidders shall proceed with the work. It should be noted that this checking by the Owner prior to start of the work shall in no way absolve the Successful Bidder of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Successful Bidder's work at any stage, the same shall be remedied by the Successful Bidder.

3.03.00 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Owner shall be taken by the Successful Bidder jointly with the Owner over the original ground prior to starting actual grading work and after setting out these initial levels and cross-sections shall be jointly signed by the Successful Bidder and the Owner before commencement of work.

3.04.00 Clearing and Grubbing etc.



The area to be excavated or filled shall be cleared out of fences, rubbish, slush, etc. and levelled up.

Before grading is started, all the spoils and unserviceable materials and rubbish shall be removed from the site to approved disposal areas within a lead of 10KM as may be specified. Useful materials, saleable timber, firewood, steel scrap, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner.

3.05.00

Classification

Materials involved in grading shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Successful bidder:

a) **Ordinary and hard soil**

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) **Soft and Decomposed Rock**

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction. The mere fact that the Successful bidder resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock.

3.06.00

Earthwork in Excavation

3.06.01

General

Before commencement of excavation/filling the existing ground surface shall be cleared in accordance with Clause no. 3.4.0.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the Successful Bidder, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering,



disposal, etc.

This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even below the final level and the same shall be filled with lean PCC (M10) upto the founding level.

3.06.02 **Excavation in Ordinary Soil, Hard Soil & Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines, drains, trenches, etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation.

On completion, the work shall be finally checked and approved by the Owner. Further work shall be resumed after getting clearance from the Owner.

3.06.03 **Excavation in Hard Rock**

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

3.06.04 **Blasting is not permitted since work is to be carried out within the existing running plant.**



3.06.05 **Disposal**

The excavated spoils shall be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Owner:

- a) By stacking separately the materials suitable for area filling and materials not suitable.
- b) By stacking it temporarily for use in backfilling at a later date.
- c)
 - i) by either spreading, or
 - ii) Spreading and compacting at designated filling areas and/or disposal areas.

3.06.06 **Dewatering**

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Successful Bidder shall remove by pumping or other means approved by the Owner, any water inclusive of rain water and subsoil water accumulated in the area. Method of dewatering shall be got approved by the Owner.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain i.e. Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.06.07 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Successful Bidder may need to construct temporary drainage systems to drain surface





water from working areas.

3.07.00 Treatment of Slips

The Successful Bidder shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Successful Bidder, the same shall be removed by him.

3.08.00 Earthwork in Filling

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Owner, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated soils or from borrow pits in selected areas designated/approved by the Owner. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murmur or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Owner, Successful Bidder shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed of as directed by the Owner within a lead of 5 KM after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Owner. Before commencement of area filling the existing top soil shall be removed up to a minimum depth of 150 mm, or more, as directed by the Owner in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 300mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Owner.

- a) Each layer of earth of cohesive in nature shall be compacted to 90% of proctor's dry density unless otherwise permitted/directed by the Owner.
- b) Each layer of earth of non-cohesive in nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Owner. Each shall be compacted with approved machine





(mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Owner.

The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tons roller.

- i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.
- ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimize the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Owner and shall conform to the stipulations laid down in IS:4701.

The cohesion-less soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the Successful Bidder's cost as directed by the Owner/Consultant. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the Successful Bidder's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill shall be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken

material and earth shall be laid and consolidation carried out by a 12 tonnes roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling, shall be disposed of in designated disposal areas within a lead of 10KM as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Owner.

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Owner.

3.09.00 Compaction Control

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Successful Bidder in accordance with these specifications and as directed by the Owner.

The Successful Bidder shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Successful Bidder is to obtain the Owner's/Consultant's approval for the firm to be used. The Successful Bidder may undertake this work with the Owner's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Owner/Consultant based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The Successful Bidder shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Owner.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

Tests shall be undertaken by the Successful Bidder as per IS 2720 and as required by the owner. The results and reports shall be submitted to the Owner/Consultant for approval. Test failures if any are to be immediately notified to the Owner/Consultant, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction.

Each layer is to be tested in a manner that is representative of its full depth. The Owner/Consultant may at his discretion instruct the Successful Bidder to increase or decrease the frequency of testing.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area shall be checked as per the drawings after the area is completely dewatered. The work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by lean mix PCC M10. Over excavation of the sides shall be made good by the Successful Bidder. The excavation work shall be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling



The degree of compaction required shall be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved shall be as decided by the Owner. The work of area filling shall be accepted after the Owner is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted before starting the work.

- i) Equipment, machinery & earthmoving vehicles, available with the Successful bidder and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.
- ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.
- iii) Method of transportation.

5.02.00 After Award of Contract

After award of contract the Successful Bidder shall submit the following for approval and adoption:

- a) The Successful Bidder shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area-filling quantities shall be balanced, minimizing temporary stacking of soils.

It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Successful Bidder. The initial programme being submitted by the Successful Bidder should have sufficient flexibility to take care of such reasonable variations.

- b) The Successful Bidder shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Owner/Consultant for adoption.





Tender Specification
for
Chimney

NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: III

**GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: III
Earthwork in Excavation and Backfilling



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CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	EXECUTION	3
4.00.00	TESTING AND ACCEPTANCE CRITERIA	13
5.00.00	INFORMATION TO BE SUBMITTED	13



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: III
Earthwork in Excavation and Backfilling**



**VOLUME: II-B
PART-A**

SECTION-III

**GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder by Chimney Package

The work to be provided for by the Successful Bidder of Chimney Package, unless specified otherwise, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.
- b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of soils, disposal area, fencing, etc. and all other details as may be required by the Owner.
- c) To carry out sampling and testing and submit to the Owner/Consultant, results of soil compaction tests whenever required by the Owner/Consultant to assess the degree of compaction.

2.02.00 Work to be provided for by others

No work under this specification shall be provided by any agency other than the Successful Bidder of Chimney Package unless specifically mentioned elsewhere in the Contract.





2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Consultant shall be followed :-

IS:2720 (Part-II)	Determination of Moisture Content
IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.
IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.
IS:2720 (Part-xxix)	Determination of Dry Density , in place, by core cutter method.
IS:2720 (Part- xxviii)	Determination of Dry Density of soils, in place, by sand replacement methods.
IS:3764	Safety code for Excavation work.
IS:4081	Blasting and Successful Drilling Operations
IS:4701	Earthwork on canals

2.04.00 Conformity with Designs

Successful Bidder of Chimney Package is to carry out the work as per the drawings which are approved by the Consultant and/or the Owner's instructions.

2.05.00 Materials to be used

2.05.01 General

All materials required for the work shall be of best commercial variety and approved by the Owner.

2.05.02 Borrow Material

Borrow material if required for back-filling shall be excavated from approved locations(within a lead of 25KM)and levels, and shall consist of material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material without any additional cost to owner.





2.06.00 Quality Control

The SuccessfulBidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

- a) Lines, Levels and Grades :
 - i) Periodic surveys
 - ii) Establishment of markers, boards etc.
- b) Back-filling :
 - i) Checking the quality of fill material
 - ii) Checking moisture content of the backfill
 - iii) Checking the degree of compaction

2.07.00 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Successful bidder must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 EXECUTION

3.01.00 Setting Out

Successful Bidder of Chimney Package shall prepare and submit to the Owner /Consultant, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Owner /Consultant with modifications and corrections, if necessary, the SuccessfulBiddershall set out the work from the control points furnished by the Owner and fix permanent points and markers for ease of future checking. Adjacent structures/foundations shall be protected while executing the Chimney construction work.

These permanent points and markers shall be fixed at intervals prescribed and checked by the Owner and certified by him after which the SuccessfulBiddershall proceed with the work. It should be noted that this checking by the Owner prior to start of the work shall in no way absolve the SuccessfulBidder of his responsibility of carrying out the work to true lines





and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the SuccessfulBidder's work at any stage.

3.02.00 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Owner will be taken by the SuccessfulBidder jointly with the Owner over the original ground prior to starting actual excavation work and after setting out. These initial levels and cross-sections shall be jointly signed by the SuccessfulBidder and the Owner before commencement of work

3.03.00 Clearing and Grubbing, etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas within a lead of 10KM as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner.

3.04.00 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) Hard Soil

This shall include:

- i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
- ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
- iii) soling of roads, paths, etc., and hard core ;



- iv) macadam surfaces such as water bound, and bitumen/tar bound;
 - v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
 - vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
 - vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.
- c) **Soft and Decomposed Rock**
- This shall include:
- i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
 - ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
 - iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
 - iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.
- d) **Hard Rock (requiring blasting)**
- This shall include:
- i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required;
 - ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
 - iii) boulders requiring blasting.
- e) **Hard Rock (blasting prohibited)**



Hard rock requiring blasting as described under (d) above excavation has to be carried out by chiselling, wedging or any other agreed method since blasting is prohibited within the plant premises.

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

3.05.00 **Excavation for Foundations and Trenches**

3.05.01 **General**

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the SuccessfulBidder, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Owner. The vertical faces of excavation shall not be undercut for extended footings / foundations. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Owner they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Owner /Consultant and the SuccessfulBidder shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The SuccessfulBidder shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the SuccessfulBidder shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Owner, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Owner, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Owner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even





below the final level. The extra excavation shall be filled up as instructed by the Owner (with lean PCC M10).

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Owner, due to the Successful Bidder's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than M10 concrete or richer) as directed by the Owner in each individual case.

Should the bottom of any excavation at design depth appear to be soft, unsound or unstable, the Successful Bidder shall report the matter to the Owner and if the Owner so directs, shall excavate the same to indicated depths. The extra depth shall be filled up with concrete M10 or such other material as the Owner shall direct.

In formation of rock requiring blasting, those overcuts which are unavoidable shall be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Owner and shall be the property of the Owner.

3.05.02 **Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall be finally checked and approved by the Owner. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Owner may order to suspend the work at any stage and instruct the Successful Bidder to carry out the balance work just before the foundation work of the structure can be started.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres,





steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

As blasting is prohibited, the excavation shall be carried out by chiselling, wedging or any other approved method.

3.05.04 **NOT USED**

3.05.05 **Disposal**

The excavated spoils shall be disposed of in any or all the following manners:

- a) By using it for backfilling straightway.
- b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.
- c)
 - i) By either spreading or
 - ii) spreading and compacting at designated filling areas and / or disposal areas.
- d) By selecting the useful material and stacking it neatly in areas designated by the Owner for use in backfilling by some other agency.

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Owner within a lead of 10KM.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.05.07 **Protection**

The Owner shall be notified by the Successful Bidder as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Owner, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval by the Owner. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Owner.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.



The SuccessfulBidder shall protect all under-ground services exposed by excavation. The SuccessfulBidder shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean. The use of mechanical equipment shall not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. The existing facilities shall be retained either by modifying or relocating as the case may be without any additional cost to owner.

3.05.08 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the SuccessfulBidder may need to construct temporary drainage systems to drain surface water from working areas.

3.05.09 Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The SuccessfulBidder shall remove by pumping or other means approved by the Owner any water inclusive of rain water and subsoil water accumulated in excavation and keeps the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Owner but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain i.e.Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.05.10 Timber Shoring



Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Owner. It shall be the responsibility of the Successful Bidder to take all necessary steps to prevent the sides of trenches and pits from collapsing. Since the work is to be executed in the existing plant, the safety of the adjacent structures including foundation shall be protected.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Owner. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacing, cross strutted with ballies or as directed by the Owner. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Owner. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**

The Successful Bidder shall take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Successful Bidder, the same shall be removed by him and payment shall be made to him on appropriate item rate





of earthwork. Slips caused due to negligence of the SuccessfulBiddershall be cleared and back-filled later by him.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Owner obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Owner. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Owner may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete. No extra cost shall be claimed by the bidder on account of this.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Owner. Compaction of the structure backfill by inundation with water shall not be permitted. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Owner.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Owner. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**



Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or laterite or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings or as specified elsewhere in the specification.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling up to a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock, laterite or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 Filling in Disposal Area

Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within a lead of 10KM. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers shall be employed and compaction done to the satisfaction of the Owner at the optimum moisture content which shall be checked and controlled by the Successful Bidder.

In certain cases the Owner may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 Approaches and Fencing

The Successful Bidder should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.



3.09.00 Lighting

Full scale area lighting is to be provided by the bidder if night work is permitted or directed by the Owner. If no night work is in progress, red warning lights should be provided by the bidder at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimensions of the pits shall be checked as per the drawings after the pits are completely dewatered the work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of M10 proportion and/or richer and/or by compacted earth, as directed by the Owner/Consultant. The choice of grade of concrete shall be a matter of unfettered discretion of the Owner / Consultants.

Over excavation of the sides shall be made good by the SuccessfulBidder while carrying out the back-filling.

The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 Back-filling

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part - VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling shall be accepted after the Owner is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted before commencing the work.

5.02.00 After Award of Contract

After award of the Contract the SuccessfulBidder shall submit the following for approval and adoption:





**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- a) SuccessfulBidder shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme should show how the excavation and back-filling quantities shall be balanced, minimising temporary stacking of soils. It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the SuccessfulBidder. The initial programme being submitted by the SuccessfulBidder should have sufficient flexibility to take care of such reasonable variations.

- b) The SuccessfulBidder shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Owner/Consultant for adoption.





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: IV

**GUIDELINE
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: IV
Cement Concrete (Plain & Reinforced)



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	INSTALLATION	12
4.00.00	SAMPLING AND TESTING	45
5.00.00	ACCEPTANCE CRITERIA	46
6.00.00	LIST OF I.S. CODES AND STANDARDS FOR REFERENCE	47



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: IV
Cement Concrete (Plain & Reinforced**



**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: IV

**GUIDELINE
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or pre-cast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Consultant shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder.

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

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- c) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- d) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.
- e) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- f) Design and submit for approval concrete mix designs required to be adopted on the job.
- g) Furnish samples and submit for approval results of tests of various properties of the following:
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- i) For supply of certain materials normally manufactured by specialist firms, the Successful Bidder shall produce, if directed by the Owner/Consultant, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Successful Bidder, jointly and severally.

2.02.00 Work by Others

No work under this specification shall be provided by any agency other than the Successful Bidder unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 After award

The following technical information shall be furnished after award:





- a) Source and arrangement of processing of aggregates proposed to be adopted.
- b) Type of plant and equipment proposed to be used.
- c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02 After Award of Contract

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

- a) Programme of Execution and Requirement of Materials

This Master Programme may have to be reviewed and updated by the Successful Bidder, quarterly or at more frequent intervals as may be directed by the Owner's Consultant depending on the exigencies of the work.

Detailed day to day programme of every month shall be submitted by the Successful Bidder before the end of the previous month.

- b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Owner/Consultant, in sufficient quantities for approval. Approved samples shall be preserved by the Consultant for future reference. The approval of the Owner/Consultant shall not, in any way, relieve the Successful Bidder of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates
- ii) Admixtures
- iii) Plywood for Formwork
- iv) Embedded and anchorage materials as may be desired by the Owner/Consultant.
- v) Joint sealing strips and other waterproofing materials.
- vi) Joint filling compounds
- vii) Foundation quality Rubber Pads





c) Design Mix

Design mix as per Clauses 2.01 (f) & 3.04 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., shall be submitted to the Owner/Consultant for his approval before it can be used on the works. After approval of design mix if the bidder changes the source of the aggregates or brand/type of the cement for any reason, fresh design mix shall be carried out and get approved by the owner.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b).

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (b).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (d).

g) Mill Test Reports for Cement & Reinforcing Steel

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Owner/Consultant in accordance with Clause 2.04 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 Conformity with Design

The Successful Bidder shall prepare check lists in approved proforma which shall be called 'Pour Cards'. These Pour Cards shall list out all items of work involved. The Successful Bidder shall inform the Owner/Consultant, sufficiently in advance, whenever any particular pour is ready for concreting.





He shall accord all necessary help and assistance to the Owner/Consultant for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Owner/Consultant shall give written permission on the same 'Pour Card' allowing the Successful Bidder to commence placement of concrete. Details of all instructions issued by the Owner/Consultant and the records of compliance by the Successful Bidder, deviations allowed by the Consultant and any other relevant information shall be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', shall be prepared by the Successful Bidder on approved proforma. The Pour Cards along with accompaniments shall be handed over to the Owner before starting placement of concrete.

One of the mix designs developed by the Successful Bidder as per the I.S. Specifications and established to the satisfaction of the Owner by trial mixes shall be permitted to be used by the Owner, the choice being dictated by the requirements of designs and workability.

The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete shall be as approved or directed by the Owner.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Code unless stated otherwise and be of best approved quality.

2.05.02 Cement

Generally cement shall be 43 grade ordinary Portland Cement conforming to IS-8112. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Owner/Consultant:

- a) 53 Grade ordinary Portland Cement conforming to IS-12269
- b) Rapid hardening Portland Cement conforming to IS-8041
- c) Portland slag cement conforming to IS-455
- d) Hydrophobic Cement conforming to IS-8043
- e) Low heat Portland Cement conforming to IS : 12600
- f) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 Aggregates





Aggregates shall be natural or crushed stone or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Owner/Consultant.

a) Coarse Aggregate

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

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Owner/Consultant may ask the Successful Bidder to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 (latest revision) is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works. Normally river sand shall be used as fine aggregates.

In case of unavailability of normal specified river sand, the M sand or Crushed stone sand shall be used with the approval of the Owner /Consultant as per given criteria/specifications below.

- i) As per Cl. 3.1.4 , of IS-383 (latest revision) the terminology of M-sand (manufactured sand) as defined as fine aggregate manufactured from other than natural sources, by processing materials using thermal or other processes such as separation, washing, crushing and scrubbing. Generally the M-sand or Crushed stone sand for the fine aggregate is produced by crushing the hard stone.

The Crushed stone sand or M-sand conforming to the following shall only be used as fine aggregate in making concrete for sub and superstructures.

The Crushed stone sand is to be manufactured using VSI crushers only and not with HSI crushers. In order to remove the fines, Crushed stone sand manufacturer should have





mechanized washing facility unit. Crushed sand stone conforming to Grading zone –II as per IS-383 (latest rev.) shall only be used. The M-sand shall comply all the parameters and recommendations of IS: 383 (latest rev.)

- ii) The M-sand shall be used only after the following tests are to be conducted by the bidders at the NABL accredited laboratories with proven track records of performing such type of tests by sending sealed samples of the materials –
- a) Gradation Test.
 - b) Petrography.
 - c) Silt content.
 - d) Permeability test.
 - e) Adulteration test.
 - f) Design Mix Report.
 - g) Chemical Analysis Report

Using of M-Sand/Crushed Stone Sand based on the Test reports shall only be done after written approval of Engineer–In-Charge.

- iii) The Crushed stone sand in general shall not be used for the following structures/facilities :-
- a) Structures constructed using slip form technology
 - b) All internal & external plastering works.

The structures where the slip form construction is envisaged the M-sand or Crushed stone sand may be used for casting its foundations only as they are not constructed using slip formTechnology.

- iv) Special care for design mix, cement content and necessary curing in the initial stage shall be taken care of while using M-sand /Crushed stone sand. However if the results are not satisfactory, the use of crushed stone sand shall not be allowed for all RCC floor slab upto and including 150 mm thickness, which are directly exposed to the atmosphere immediately after casting. In such cases the ordinary river sand shall be used.
- v) The M-sand/Crushed stone sand manufacturing locations shall be inspected by the Owner before giving approval for supply. The bidder shall ensure that the manufacturing process is done using only VSI crushers & shall have mechanized water washing unit for removal of fines in the Crushed stone sand manufactured.



Aggregates smaller than 4.75 mm and within the grading limits and other requirements set in IS-383 (latest rev.) as termed as fine aggregate. Only fine aggregate from approved sources and conforming to IS: 383 (latest rev.) shall be used for execution. The bidder shall have well developed site laboratory and quality control team to take extra care while manufacturing and casting concrete using M-sand/ Crushed stone sand.

Normally, any particular structure shall be constructed by using any one type of sand (fine aggregate) only as per the direction / approval of engineer-in-charge. In general, it is not permitted to use different types of sand in any particular structure.

2.05.04 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 shall be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-1 of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 Admixture

Only admixture of approved quality shall be used when directed or permitted by the Owner/Consultant. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075 , Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or equivalent.

b) Retarding admixtures :

- Modified lignosulphonate based set retarding concrete admixture like , "Plastiment R" or equivalent.





- c) Water reducing admixtures :
- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or equivalent.
- d) Air entraining admixtures :
- Modified lignosulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER" or equivalent.
- e) Water proofing admixtures

All water retaining structures shall be provided with water proofing admixtures.

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

However, the Successful Bidders shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Owner/Consultant:

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

2.05.06 Reinforcement

Reinforcement shall be of Fe 500 grade Corrosion Resistant Steel and as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.





Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Owner/Consultant, shall not be used for concrete and shall be removed from site immediately, failing which, the Ownershall be at liberty to get the materials removed and Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Successful Bidderto the satisfaction of the Owner/Consultant.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Owner/Consultant, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Owner/Consultant.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Owner/Consultant. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Successful Biddershall establish and maintain quality control for different items of work and materials as may be directed by the Owner/Consultant to assure compliance with contract requirements and maintain and submit to the Owner/Consultant records of the same.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

The quality control operation shall include but not be limited to the following items of work :

- a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
- b) Aggregate : Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
- c) Water : Impurities tests.
- d) Cement : Tests to satisfy relevant IS Specifications
- e) Formwork : Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
- f) Reinforcement : Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or certificates to satisfy relevant IS Specification
- g) Grades of concrete : Usage and mix design, testing of all properties.
- h) Batching & Mixing : Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints : Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
- j) Embedded and Anchorage Items : Material, shape, location, setting.
- k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning





and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

- l) Compaction : Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Beaming plates : Lines, elevations and bedding mortar.
- n) Concrete Finishes : Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing : Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Owner/Consultant for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Owner/Consultant.

3.01.00 Washing and Screening of Aggregates

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

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

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

3.02.00 Admixture





All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Owner/Consultant reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Owner/Consultant.

3.03.00 Grades of Concrete

Structural concrete grade shall be as per stipulations mentioned in the Design criteria and for other part of the work if not covered, shall be as shown on the drawing as per grade classification of IS-456 and in case of liquid retaining structures, IS:3370 shall be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Owner/Consultant.

- a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.
- b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456 may be used if shown on drawings or approved by the Owner/Consultant. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Owner/Consultant is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes shall be designed by the Successful Bidder to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design shall keep in view the following considerations:

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.





- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.
- e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Owner/Consultant. The Successful Bidder shall strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the Successful Bidder with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE - I

STRENGTH REQUIREMENT OF CONCRETE

Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)	
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40



NOTE: 1 - Concrete Grade M-15 shall be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. Grades of concrete lower than M-35 shall not be used in reinforced concrete. These mixes need not be designed.

TABLE - II

**MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE
DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT
VALUES OF WATER - CEMENT RATIO**

(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0
Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE : 1 - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Owner/Consultant.



NOTE : 2 - It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

NOTE : 3 - The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be 400 kg/cum and as per Vol-IIB-Section-I, Part-A, Sub Section-I.

3.07.00 Water-Cement Ratio

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

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456 shall be selected by trial and error. The values of water-cement ratios for different grade and mix designs shall have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Owner/Consultant. Frequent checks on test shall have to be carried out and the water-cement ratios shall be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Successful Bidder's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

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

3.07.02 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemicals. Impermeability may also be an important consideration.





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

In general the water cement ratio between 0.4 and 0.45 shall be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete.

The Successful Bidder may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super-plasticizer. However the Successful Bidder has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It shall be preferable to use Melamine based plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE - III

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.



(NOTE: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Owner/Consultant)

With the permission of the Owner/Consultant, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Owner/Consultant, the compacting factor test in accordance with IS:1199.

3.09.00 Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Owner/Consultant:-

Very narrow space	- 12 mm
Reinforced concrete including foundation	- 20 mm
Ordinary Plain concrete M10 and below	- 40 mm
Mass concrete	- 40 mm
Mass concrete in very large structure	- 40 mm

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

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

40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions. Coarse aggregates more than 40mm size shall not be used in concrete.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Owner/Consultant for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates





constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum.

When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Owner/Consultant. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

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

Regular checks on mixer efficiency shall be carried out as directed by the Owner/Consultant as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 shall be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement, water or total aggregates being measured and within + 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner/Consultant. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Owner/Consultant, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is



continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as shall prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design shall be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Owner/Consultant, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code shall be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Owner/Consultant, shall be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Owner/Consultant and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.





Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Owner/Consultant before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Owner/Consultant and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Owner/Consultant.

Rock foundation or construction joint shall be kept moist for at least 72 hours prior to placement. Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Owner/Consultant shall have to be adopted.

Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry shall be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar shall be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Owner/Consultant, doubtful, in addition to immersion vibrators the Successful Bidder may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the Successful Bidder shall additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Owner/Consultant. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.



The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Owner/Consultant. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Owner/Consultant. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Owner/Consultant. Any deviation therefrom shall be set right by the Successful Bidder as instructed by the Owner/Consultant.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Owner/Consultant may direct to remove the portion and reconstruct or repair the same.

The Owner/Consultant shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints shall be formed in a manner specified in the drawings/ Instruction. Vertical construction joints shall be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint. For water retaining structures and leak-proof buildings suitable approved water bars shall be installed at the construction joints.

Where the location of the joints is not specified, it shall be in accordance with the following:

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.





- b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.
- c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Successful Bidder proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Owner/Consultant for study and approval without which no construction joint shall be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Successful Bidder should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness (not leaner than the grade of concrete under consideration), shall be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, the joint shall be left to harden for at least 12 - 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Clause 3.12.





3.14.00 Repairs, Finishes and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection shall not be accepted and at successful bidder's own risk and cost, shall have to be dismantled, removed and replaced by sound concrete. The Owner/Consultant may, at his sole discretion, allow to retain concrete with minor defects provided the Successful Bidder is able to repair it by approved methods. All concrete work shall be inspected by the Successful Bidder immediately after the forms are removed and he shall promptly report occurrence of any defects to the Owner/Consultant. All repair works shall be carried out as per the instructions and in the presence of the Owner/Consultant or his representative. Generally, repair work shall consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth and shape.
- c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with a cement-sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortar.
- k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 Finishing Unformed Surface



A few typical and common cases of treatment of concrete surface are cited below:

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance.

No over-trowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Owner/Consultant, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Owner/Consultant may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Successful Bidder shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Owner/Consultant, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing.



Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Owner/Consultant. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding.

Steps, as approved by the Owner/Consultant, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Owner is satisfied with the adequacy of the arrangements made by the Successful Bidder.

If permitted by the Owner, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The Successful Bidder shall arrange for the manufacturer's supervision.

The Successful Bidder shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Owner's decision regarding the adequacy of curing is final.

In case any lapse on the part of the Successful Bidder is noticed by the Owner, he shall inform the Successful Bidder or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Successful Bidder within 3 (three) hours of issuance of such instruction, the Owner shall be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Owner and at bidder's cost.

3.16.00 Reinforcement

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., shall be used as reinforcement as per drawings and directions. The reinforcing bars





shall be TMT CRS of grade Fe500 as per IS 1786(latest revision). If required, in an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077, as shown on the drawing or as directed by the Owner/Consultant.

3.16.01 Bar Bending Schedules

The Successful bidder shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Successful bidder to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Successful bidder shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Successful bidder of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 Cleaning

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

3.16.03 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Owner/Consultant. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Successful Bidder before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Owner/Consultant, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that shall injure the material. Rebending can be done only if approved by the Owner/Consultant. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat(not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Owner/Consultant at exceptional cases.





3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by three strands of No. 20 G/two strands of 18G/one strand of 16G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Owner/Consultant. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held.

The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Successful Bidder shall study the drawings thoroughly and inform the Owner/Consultant in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Owner/Consultant.

3.16.05 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Owner/Consultant, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Owner/Consultant for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out.

Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Owner/Consultant. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Owner/Consultant. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14





(fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Owner/Consultant.

3.17.00 Cold Weather Concreting

When conditions are such that any operation of concreting may be expected to be done at 5°C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Successful Bidder shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40°C while placing. Positive temperature control by precooling, postcooling or any other method, if required, shall be specified.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 Form Work

3.20.01 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The Successful Bidder shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Owner/Consultant prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Owner/Consultant.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Reckers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Successful Bidder wishes to adopt any other design criteria, he has to convince the Owner/Consultant about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its





components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Owner/Consultant shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used.

Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits shall be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Owner immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Owner. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter





release agent like "Separol/Sika form oil/ Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork.

The oiling of the formwork shall be inspected just prior to placement of concrete and redone wherever necessary.

3.20.02.01 Design

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

The design of formwork shall take into account all vertical and lateral loads that the forms shall carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The Successful Bidder shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.03 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Owner/Consultant. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Owner/Consultant shall be obtained.

3.20.04 Removal of Forms

Before removing any formwork, the Successful Bidder must notify the Consultant well in advance to enable him to inspect the concrete if he so desires. The Successful Bidder shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Owner/Consultant regularly.



The Successful Bidder shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Owner/Consultant may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Owner/Consultant in each case.

**TABLE - IV
SCHEDULE OF REMOVAL OF FORM**

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

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40°C can be reduced to those of the temperature range of 20°C to 40°C subject to approval of the Owner/Consultant.

Construction joints in beams, if required to be provided, shall be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Owner/Consultant.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal of forms shall be revised as approved by the Owner/Consultant such that the strength of this cement at the time of removal of forms match with strength of portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.05 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Owner/Consultant :

For

- a) Sectional dimension - ± 5 mm
- b) Plumb - 1 in 1000 of height
- c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Owner/Consultant. Any error, within the above tolerance limits or any other as may be specially set up by the Owner/Consultant, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.06 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Owner/Consultant.



3.20.07 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Owner/Consultant :

- a) Ordinary : These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) Plywood : These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Owner/Consultant. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.
- c) Ornamental: These shall be used where ornamental and curved surface are required and shall be made of selected best quality well-seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Successful Bidder shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Owner/Consultant.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Successful Bidder shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Successful Bidder, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Owner/Consultant. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Owner/Consultant. Items to be embedded.





- a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Lugs or plugs for door and window frames occurring in concrete work.
- e) Flashing and jointing in concrete work.
- f) Any miscellaneous embedments and fixture as may be required.

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

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter.

In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids by using water proofing admixtures and water stoppers as specified on the drawings/specifications or as directed by the Owner/Consultant. All materials are to be procured from reliable manufacturers and must have the approval of the Owner/Consultant. Where it is the responsibility of the Successful Bidder to supply the material, the Owner/Consultant may demand test certificates for the materials and/or instruct the Successful Bidder to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Owner/Consultant before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and





not prepared by cutting to size smaller pieces from larger boards at site. On already concreted surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed.

At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality\of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material shall have to be procured from reliable manufacturers as approved by the Owner/Consultant. The method of installations shall be similar to that recommended by the manufacturers for fixing on cold storage walls. . On already concreted surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.

The sealing strips shall be non-metallic like rubber or P.V.C.

Sealing strips shall not have any longitudinal joint and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs.

The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Owner/Consultant. The Successful Bidder is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Owner/Consultant, joints in rubber seals may have to be vulcanised.





Non-metallic sealing strips shall be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

- i) Plain
- ii) Central bulb
- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints shall be allowed only under unavoidable circumstances and with the specific approval of the Owner/Consultant.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Owner/Consultant taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm unless otherwise specified. The actual size and shape shall be as shown in drawings of items and/or as directed by the Owner/Consultant. The material shall be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties shall be generally as follows. The actual requirements may be slightly different as decided by the Owner/Consultant:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips shall be 3 mm and the minimum width 100 mm unless otherwise specified. The actual





size and shape shall be as shown in drawings/schedule of items and/or as directed by the Owner/Consultant. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows. The actual requirements, which shall be directed by the Owner/Consultant, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70°C
Ultimate Elongation	:	Not less than 275%

3.23.04 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 Isolation Joints

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Owner/Consultant shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Owner/Consultant. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases





If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Successful Bidder. In general unless otherwise specified, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Owner/Consultant, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Owner/Consultant, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Owner/Consultant. Admixture, if directed to be added.

Alternatively non-shrink, free flow, cementitious grout like "Sikagrout 214/ Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Owner/Consultant.

3.25.00 Precast Concrete

The Specification for precast concrete shall be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Owner/Consultant, casting shall have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Owner/Consultant, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.





All members shall be indelibly marked with a unique identification mark on a surface which shall not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the date of casting and if they are of a symmetrical section the face which shall be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Owner/Consultant. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Owner/Consultant. The Successful Bidder shall render all help with instruments, materials and men to the Owner/Consultant for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Owner/Consultant. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

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

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

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

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



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

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

The whole operation shall be done as per manufacturer's specification.

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

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %



The maximum permissible dosage of admixture shall be 2% (two percent) by weight of cement. The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/ Cu.m a melamine based super plasticizers shall be preferable.

- a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Owner/Consultant. The Successful Bidder shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Owner/Consultant.
- b) In Plaster : The concrete surface, to be plastered, shall be hacked to Owner's/Consultant's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Consultant. If desired by the Owner/Consultant, the Successful Bidder shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375°F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400°F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Owner/Consultant, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat





and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely.

In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer for waterproofing purpose.

3.26.05 Protective Coating on Inside Surface

Unless otherwise specified, Two coats of cement based two-components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt : Application for Tanking

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

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing. If required by the Owner/Consultant, tests as specified in relevant IS Codes shall be arranged by the Successful Bidder.

The Successful Bidder shall execute this work in direct collaboration with one of the well-known specialists approved by the Owner/Consultant.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. included in scope.

3.26.07 Polyethylene Films : Application in Walls or base of Structures

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

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



Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed.

On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.
- v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.
- vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- ix) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures shall be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Owner/Consultant, by using bitumen emulsion protective coating of approved manufacturer applied with two coats of Hot bituminous painting of grade 20/30 over a coat of Bitumen Primer except where special water proofing is specified for specific structures mentioned elsewhere.

3.28.00 Waterproofing by Pressure /Chemical Grouting

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's





recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cm and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Successful Bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Successful Bidder shall get the specimens tested in a laboratory approved by the Owner/Consultant and submit to the Owner/Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples shall be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Owner/Consultant.

4.03.00 Aggregates

The Successful Bidder shall carry out any or all the tests aggregates as may be required by the Owner/Consultant in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS:3550 shall be carried out by the Successful Bidder at regular intervals and whenever directed by the Owner/Consultant. The final acceptance criteria in case of doubt shall be as per IS:3025 & IS:456.

4.05.00 Admixture

4.05.01 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete shall be established by the Successful Bidder by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Owner/Consultant, the Successful Bidder shall check-up the actual percentages of air entrained





and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Successful Bidder.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Owner/Consultant may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Successful Bidder every two hours or as directed by the Owner/Consultant. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Successful Bidder. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good to the satisfaction of the Owner/Consultant.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

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

5.02.00 Acceptance Criteria

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





5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Owner/Consultant, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456.

If load testing is decided by the Owner/Consultant, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Owner/Consultant. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Successful Bidder. Alternatively, if permitted under Statutory Regulations and at the discretion of the Owner/Consultant, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Successful Bidder. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same shall be made good by the Successful Bidder to the satisfaction of the Owner/Consultant.

6.00.00 LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Consultant, shall be followed :-

IS : 73 - Indian Standard Specification for Paving Bitumen





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 269	-	Indian Standard Specification for 33 grade Ordinary Portland Cement
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
IS : 455	-	Indian Standard Specification for Portland Slag Cement
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 457	-	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete
IS : 737	-	Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose. IS:1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
IS : 1200	-	Indian Standard Specification for Method of (Part-V) Measurement of Formwork
IS : 1322	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
IS : 1489	-	Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2
IS : 1566	-	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
IS : 1609	-	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS : 1786	-	Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers
IS : 1834	-	Indian standard specification for hot applied sealing compound for joint in concrete.
IS : 2062	-	Steel for general structural purpose.
IS : 2185	-	Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2
IS : 2210	-	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
IS : 2430	-	Indian standard specification for method of sampling of Aggregate for concrete.
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators Immersion Type
IS : 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators
IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS : 2645	-	Integral Cement water proofing compound
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batches for Concrete (Single and Double Bucket type)
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolona& Admixture
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Archs
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus
IS : 7861	-	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement
IS : 8043	-	Indian standard specification for hydrophobic cement
IS : 8112	-	Indian Standard Specification for 43 grade Ordinary Portland Cement
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS : 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction
IS : 10262	-	Recommended Guideline for concrete Mix Design
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement
IS : 12330	-	Indian standard specification for sulphate resting portland cement
IS : 12600	-	Indian standard specification for low heat portland cement





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: V

**GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: V
Bored Cast in Situ Concrete Pile**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	16
5.00.00	INFORMATION TO BE SUBMITTED	21





**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: V

**GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE**

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast- in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2), Latest Revision shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

Bored Cast-in-situ RCC pile passing through top soil overburden and highly weathered rock layer and terminating in the underlying sand stone layer with a socket length not less than 3D, (where D is the diameter of the pile) within such layer, will be considered. The capacity of the pile will be confirmed by the successful bidder by necessary load testing as per BIS and by design calculations.

To get generalized & tentative idea of sub-surface stratification as a whole, the soil report available with purchaser may be studied. However a confirmatory soil investigation will be done by the contractor after award of work to ascertain the top level of rock layer for their internal assessment of Pile length only. This will in no way affect the pile parameters stipulated in this specification.

2.00.00 GENERAL

2.01.00 Work to be provided by the successful bidder

The work to be provided for by the successful bidder, unless otherwise specified, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

desired capacity.

- b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the successful bidder as per the basic plan furnished by the Engineer, if so desired by him.
- c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.
- d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.
- e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.
- f) Make necessary earthwork and approaches for movement of pile installation equipment.
- g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the successful bidder unless specified elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 8112	-	Indian Standard Specifications for 43 Grade Ordinary Portland Cement.
IS : 12269	-	Indian Standard Specifications for 53 Grade Ordinary Portland Cement.
IS : 383	-	Indian Standard Specifications for Natural Sources for Concrete.
IS : 432	-	Indian Standard Specification for (Part - I) Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.
IS : 455	-	Indian Standard Specifications for Portland Slag Cement.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete.
IS : 516	-	Indian Standard Specifications for Methods of Test for Strength of Concrete.
IS : 1199	-	Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.
IS : 1786	-	Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.
IS : 2062	-	Steel for General Structural Purposes
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.
IS : 2502	-	Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.
IS : 2722	-	Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.
IS : 2911	-	Code of Practice for Design and Construction of Pile Foundations - Bored Cast-in-situ piles. (Part-I/Sec.2)
IS : 2911	-	Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.
IS : 4926	-	Indian Standard Specifications for Ready Mixed Concrete.
IS : 9716	-	Guide for Lateral Dynamic Load Test on Piles.

2.04.00 **Conformity with design**

The successful bidder will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the successful bidder from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

defective or inaccurate.

2.05.00 Materials

2.05.01 General

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 Casing

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 Concrete

Concrete type M35 grade shall be used for piles. Materials and method of manufacture for cement concrete shall in general be in accordance with IS: 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS: 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Successful bidder at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. The water-cement ratio shall not exceed 0.5. To achieve the specified slump using specified water cement ratio without compromising with strength, suitable plasticiser, if required, may be used at no extra cost, subject to approval of NTPL. If concentration of Sulphate (measured as SO_3) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement shall be used. The minimum cement content should be 400 for M35 grade concrete respectively based on subsoil condition requirement besides that required from strength and other considerations.

The physical properties, mechanical properties & gradation of coarse & fine aggregate shall follow IS:383. Testing of aggregate properties (if desired by purchaser) shall follow relevant parts of IS:2386.

Refer General Specification for civil work for construction water.

Preliminary mix design shall be done in accordance with IS:10262 & SP:23 subject to approval of NTPL. Cube tests, slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at site / site laboratory at contractor's own



cost. Concrete cube tests shall be done as per IS : 516. The calibration certificate (not older than one year) of the testing machine.

The calibration certificate (not older than one year) of the testing machine shall be available at site. If purchaser feels any doubt about the calibration, the contractor shall get it checked at an approved laboratory at his own cost. All such tests shall be conducted in presence of purchaser. At least one set (3 cubes for 7 days & 3 for 28 days strength) of cube shall be tested for every 10 piles or at any deterioration in concrete quality if felt purchaser, whichever occurs earlier. Slump tests (apparatus conforming to IS:IS:7320) shall be carried out at least once for each pile or more frequently, if desired by purchaser.

2.05.04 Reinforcement

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786. All bars shall be Corrosion Resistant Steel(CRS). Test certificate for reinforcement steel shall be obtained from recognised agency, before using. The purchaser may desire to check the testing of the same and the contractor shall arrange it in an approved laboratory at his own cost.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the successful bidder's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 Casing

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 Quality Control

The successful bidder shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure



compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

- a) Location and plumb : Control survey for accuracy in plan and check for verticality.
- b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.
- c) Boring : Boring method to suit soil profile.
- d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.
- e) Inspection of pile
- f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a 'non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS : 2911 (Part - I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The successful bidder shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the bidder bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The bidder will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable



continuous hard strata based on approved soil data. In case the successful bidder is required to drive piles to greater or shallower depths than that is envisaged, no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

IS:2911 (Part 1/Section 2) : 'Code of practice for design & construction of Bored Cast-in-Situ concrete piles', IS : 2911 (part 4) 'Load Test on Piles & IS : 14593 : 'Design And Construction of Bored Cast-in-situ Piles founded on Rocks – Guidelines' will be referred to in conjunction with this specification during the entire design, construction & Load Testing work. These code form the integral part of this specification.

The piles will be bored cast-in-situ cylindrical type RCC piles of 450 mm &/or 550 mm &/or 750 mm &/or 1000 mm dia terminated within underlying sand stone layer with a rock- socket length not less than $3D$ (where D is the diameter of the pile) , to achieve the design capacity. Minimum center to center spacing between adjacent piles will be $2.5 D$.

Sub-surface profile & Level of weathered Rock layer in different locations of the site are furnished in the Soil Investigation report available with purchaser .

The contractor will submit the structural design of pile for approval of purchaser/consultant . The contractor will guarantee the minimum safe vertical compressive design load capacities for piles

Capacity of Single Pile

A) Vertical Compressive capacity

The contractor will submit capacity of piles diameter wise along with design requirement .

B) Uplift Capacity

The Uplift capacity (for tension pile only) of single pile (with $3D$ rock socket), at this site, will be considered as 25 % of their respective Compressive capacity plus buoyant weight of pile. However, the same has to be confirmed by the successful contractor, by field load test on Trial pile before taking up the working piles.

C) Lateral Capacity

The Lateral capacity of single pile, at this site, will be considered as the minimum of the following:-

- i) 5 % of their respective compressive capacity of pile.
- ii) Lateral pile capacity assessed by the successful contractor by initial Pile Load Test on Trial Pile at selected representative locations, before taking up working piles. At least 3 Nos. of such tests is necessary, locations for which will be mutually decided by the contractor & purchaser.

The successful bidder shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., quality, workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Successful bidder with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Successful bidder to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length with no extra cost to Owner for deviation in length above or below the stipulated basic length.

The load test must be satisfactory and accepted by the Engineer. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the test shall be repeated to the satisfaction of the engineer without any extra cost.

3.03.00 Identification of Piles

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 Sequence of Piling

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity

reduced by subsequent boring/driving operation. The Successful bidder shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 Boring

3.05.01 With Casing

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Successful bidder based on visual inspection of recognizable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Successful bidder to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Successful bidder on such pro- portion of the heaved piles which shall be ordered by the Engineer.



3.05.02 With Drilling Fluid

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in inter- mediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 Spacing of Piles

In general, all piles shall have a minimum spacing on centres of $2.5d$ (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 Placing of Reinforcement

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 Concreting

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval



of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilized and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 Tremie Method of Concreting

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

- a) The concrete shall be coherent, rich in cement (not less than 400 kg/m³) and of slump not less than 100 mm.
- b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.
- c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.
- d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.
- e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.
- f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the

laittance from being entrapped within the pile.

- g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laitance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 Concreting in Cased Holes

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 Cut-off Level

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 600 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 Steel Pipe or Casing tube

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Successful bidder's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days.

The concreted length of piles shall be measured from the toe of pile to cutoff level of pile.

Boring of any pile shall not be carried out within a clear distance of three times of the pile diameter from the adjacent pile which has been freshly concreted within past 24 hours.



The contractor shall take all necessary actions to prevent side collapse (if any) of pile bore at his own cost.

The contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places as indicated by purchaser. The cost of such disposal shall be deemed to have been included in the rate of piling.

Founding Strata

All the piles shall be founded on approved bearing strata or upto specified depth as per design requirement & as mentioned in the drawing.

In general, criteria for approval of founding strata shall be agreed between purchaser & contractor based on visual identification of recognisable samples recovered from pile borehole & specified SPT criteria.

In case, pile is socketted in rock strata, a minimum socketted length of Thrice the pile diameter (3D) shall be provided. The founding rock strata shall be identified by recognisable rock piece sample obtained by boring tool from pile bore &/or wash of rock powder in return water, SPT N > 100 at termination level and as decided by purchaser.

Termination criteria may be standardised / modified at site by purchaser depending on actual sub-surface material encountered and rate of penetration through such strata with the available equipment & accessories.

3.11.00 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 Removal of Spoil

The Successful bidder shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the Scope.

3.13.00 Back-Filling of Abandoned Borings

The Successful bidder shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.



All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix M10 so that resistance to lateral forces on neighbouring piles are developed.

3.14.00 Record for Installation of Piles

The Engineer and the Successful bidder shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Successful bidder. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

- a) Date of completion, pile number & sequence of installation of piles in a group.
- b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.
- c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.
- d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.
- e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.
- f) Method of cleaning bottom of hole at founding level before concreting.
- g) Records of additional borings or other subsurface information obtained during the process of boring.
- h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Successful bidder. These data along with the load-displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 Defective Piles

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified, such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Successful bidder shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

- i) Replacement of defective piles.
- ii) Providing additional piles.
- iii) Alteration in design of pile caps.

3.16.00 Idle Period

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the successful bidder will not be entitled to any claim due to this reason.

3.17.00 Test Pile

The successful bidder may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part - IV) or as directed by the engineer.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The successful bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the successful bidder shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of RCC

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 Components of Steel

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 Load Tests

4.04.01 General

Initial tests and/or routine tests as indicated in the FQP or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the tests described below shall be carried out as indicated in the FQP or as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 Vertical Load Test [as per IS : 2911 (Part-IV)]

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an overload of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

- i) Test load to design load
- ii) Design load to 50% of design load
- iii) 50% of design load to 25% of design load
- iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02 mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Successful bidder and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Successful bidder to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Successful bidder and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Successful bidder shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Successful bidder shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Successful bidder to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Successful bidder shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement.

Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 Lateral Load Test

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the Engineer. The safe lateral load on pile shall be taken as the least of the followings :

- a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.
- b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 Pull-out Test

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12 mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

- a) Two-thirds of the total load at which the load-displacement is 12 mm.
- b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 Non-destructive Dynamic Test on Working Piles

4.05.01 "Low Strain" Method for Integrity Investigation of Concrete Piles :

The method of testing shall conform to ASTM D 4945.or equivalent Indian Standards.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Successful bidder. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 "High Strain" Method for Determining of Pile Capacity

The method of testing shall conform to ASTM D 4945 or equivalent Indian Standards.

All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the successful bidder. For every hammer below, the analyser shall determine the following data :

- i) Pile bearing capacity
- ii) Transferred energy
- iii) Maximum compression force
- iv) Maximum tension force
- v) Maximum impact velocity
- vi) Maximum acceleration
- vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 Acceptance Criteria

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

- a) The head of the pile shall be within 75 mm of the specified position on the drawings.
- b) The pile shall not be out of plumb by more than two percent.
- c) The toe of the pile shall be at the approved bearing level in each case.
- d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for

this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

- e) The results of the load tests incl. non- destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.
- f) In case of single pile the positional tolerance shall not be more than 50 mm.

4.07.00 Lateral Dynamic Load Test on Piles

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

- i) Frequency of vibrations
- ii) Amplitude of vibrations
- iii) Imparted dynamic force
- iv) Natural frequency
- v) Damping coefficient
- vi) Soil-pile stiffness
- vii) Coefficient of horizontal soil modulus variation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.01 Design Data



The successful bidder shall submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 Programme of Construction

The successful bidder will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful bidder is to submit the following details :

5.02.01 Execution Plan

The successful bidder will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 Detailed Construction Programme

A detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the bidder is to supply as per the terms and conditions of contract is to be submitted.

5.02.04 Test Results

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: VI

**GUIDELINE
FOR
FABRICATION OF STRUCTURAL STEEL WORK**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: VI
Fabrication of Structural Steel Work**



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CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	WORKMANSHIP	11
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	19
5.00.00	INFORMATION TO BE SUBMITTED	23



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: VI
Fabrication of Structural Steel Work**



**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: VI

**GUIDELINE
FOR
FABRICATION OF STRUCTURAL STEELWORK**

1.00.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder

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

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on Successful Bidder's design drawings approved by the Consultants.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the Successful Bidder along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the Successful Bidder shall be in adequate quantity to avoid delay in erection.
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.





- f) Suitably mark, bundle and pack for transport all fabricated materials.
- g) Prepare and furnish Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.02.00 Work by others

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

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

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

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





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IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile 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 & testing metal arc welders.
IS : 818	-	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS : 819	-	Code of practice for resistance spot welding for light assemblies in mild steel.
IS : 822	-	Code of practice for inspection of welds.
IS : 919 (Part - 1&2)	-	Recommendations for limits and fits for engineering.
IS : 1161	-	Steel Tubes for structural purposes.
IS : 1182	-	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work
IS : 1239 (Part - 1&2)	-	Mild steel tubes, tubulars and other wrought steel fittings
IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws and nuts of product grade C.
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A & B.
IS : 1365	-	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.
IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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





IS : 9595 - Recommendation for metal arc welding of carbon manganese steels.

PAINTING

IS : 117 - Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.

IS : 128 - Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.

IS : 1477 - Code of practice for painting of ferrous metal
(Part - I & II) in building.

IS : 2074 - Ready mixed paint, air-drying red-oxide zinc chrome priming.

IS : 2339 - Specification for aluminium paints for general purposes in dual container.

IS : 2932 - Specification for enamel, synthetic exterior type - I.

IS : 2933 - Specification for enamel, synthetic exterior type - II.

2.04.00 Conformity with Designs

The Seller shall design all connections and supply all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Consultant keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Consultant.

Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

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





The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

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

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

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

2.05.03 Electrodes

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

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

2.05.04 Bolts and Nuts





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

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

- a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen : -
- 1) IS:1367 - Technical supply conditions for threaded fasteners.
 - 2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.
- b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Consultant.
- c) High Strength Friction Grip Bolt : HSFG Bolts shall be high tensile of 20 mm dia or higher diameter and of property class 8.8 (minimum) as per IS – 1367 (Latest) for all major connection. All bolts, nuts and washers shall be procured from the approved manufacturers. The bolted joints shall be designed for friction type connection and the HT bolts shall be tighten to develop the required pretension during their installation.

2.05.05 Washers

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

- 1) IS : 1977 - Structural steel (Ordinary Quality) St-42-0
- 2) IS : 2062 - Steel for general structural purpose





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 3) IS : 8500 - Structural steel - micro alloyed (medium & high strength quality)
- 4) IS : 6623 - High Strength Structural Nuts
- 5) IS : 6649 - Hardened and tempered washers for high strength structural bolts & nuts.

2.05.06 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Priming as mentioned elsewhere in this specification.

2.06.00 Storage of Material

2.06.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the Successful Bidder's yard immediately, failing which, the Consultant shall be at liberty to get the material removed. The Successful Bidder shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in Successful Bidder's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 Steel

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

2.06.03 Electrodes

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

2.06.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be





stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 Paints

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

2.07.00 Quality Control

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

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

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

- a) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection reports





- h) Galvanizing : Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.08.00 Standard dimensions, forms and weights

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

2.09.00 Shop Drawings

The Successful Bidder shall submit to the site-in-charge, the Schedule of Fabrication and delivery of structural steelwork. He shall start to submit progressively for approval the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work.

The sequence of submission of shop drawings shall match with the approved fabrication and delivery schedule. The shop drawings shall be in general conformity with the design requirements as well as specification and shall ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. shall be entirely the Successful Bidder's responsibility.

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

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





The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion.

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

The Successful Bidder shall be responsible for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him.

3.00.00 WORKMANSHIP

3.01.00 Fabrication: Fabrication may be either shop fabricated or Site fabricated.

3.01.01 General

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

3.01.02 Straightening Material

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

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel





only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Consultant.

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

3.01.04 Planning of edges

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

3.01.05 Clearances

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

3.02.00 Bolted construction

All bolted connections shall have a minimum of 2 bolts with c/c distance limited to minimum spacing as per IS: 800.

3.02.01 Holes

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

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal





to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

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

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

3.02.02 Assembly

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

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

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings. For base plates at any level, the minimum thickness of the washer plate shall be 0.8 times of base plate thickness.

3.03.00 Welded Construction

3.03.01 General

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

3.03.02 Preparation of Material





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

3.03.03 Assembling

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

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

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

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Consultant, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Consultant.

3.03.05 Welding technique

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





weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

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

Minimum size of fillet weld based on thickness of thicker element connected shall be

- (a) 6 mm for plate up to 20mm thick
- (b) 8 mm for 21 to 30 mm thick
- (c) 10 mm for 31 to 50 mm thick
- (d) 12 mm for 51mm & above

All members shall be welded to the gusset for full contact length available.

Minimum fillet weld thickness for site welds shall be 8 mm with plates of thickness more than 8 mm.

Spacer plates for double and starred angle members shall be provided at a spacing of not more than 40 r (min) for compression elements and 80 r(min) for tension elements, where r (min) is rxx and ryy of the single angle respectively.

All gussets shall be of minimum 8mm thick. In the drawings thickness of gusset plate corresponding to forces in members shall be

- (a) 8 mm gusset plate for forces up to 15 tonnes.
- (b) 10 mm gusset plate for forces 16 – 25 tonnes.
- (c) 12 mm gusset plate for forces 26 – 40 tonnes.
- (d) 14mm gusset plate for forces 41-60 tonnes.
- (e) 16 mm gusset plate for forces 61 - 80 tonnes.
- (f) 18 mm gusset plate for forces 81 - 100 tonnes.
- (g) 20 mm gusset plate for forces 101 ton and above.

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

3.03.06 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg. C. However, if welding is to be undertaken at low





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

3.03.07 Peening

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

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be accepted by the Owner.

3.04.00 Finish

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

3.05.00 Slab bases and caps

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

3.06.00 Lacing bars





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

3.07.00 Separators

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

3.08.00 Bearing Plates

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

3.09.00 Architectural Clearances

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

3.10.00 Shop connections

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

3.11.00 Castings

Steel castings shall be annealed

3.12.00 Shop erection

**3.13.00 The steelwork shall be checked for accuracy of fit before despatch..
Shop painting**

3.13.01 General

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

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust,





weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the pre-cleaning, the metal surface shall immediately be painted with primer as per .cl 3.18.00/vol II B/sec –I/Part C/SS III

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be as per .cl 3.18.00/vol II B/sec –I/Part C/SS III

3.13.02 Inaccessible parts

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

3.13.03 Contact surfaces

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

3.13.04 Finished surfaces

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

3.13.05 Surfaces adjacent to field welds

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

3.14.00 Galvanizing

3.14.01 General

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





3.14.02 Surface Preparation

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

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

3.14.03 Procedure

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

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

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

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

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all work shall be made by the Owner /Consultant at the place of manufacture prior to delivery. The Owner /Consultant shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities





for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

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

The Successful Bidder shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Successful Bidder shall carry out sampling and testing in accordance with the relevant Indian Standards and as required by the owner/consultant.

The Successful Bidder shall get the specimens tested in a laboratory approved by the Owner /Consultant and submit to the Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by the Seller shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used.

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

Steel shall conform to IS: 2062 (latest) for rolled structural steel members.

4.02.03 Testing Criteria for checking Lamination in raw steel plates

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

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





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

4.02.04 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Owner/Consultant may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Owner/Consultant, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Owner/Consultant shall have option to reject or instruct any remedial measures to be taken.

4.02.05 Bolts, nuts and washers

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

4.02.06 Shop painting

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

4.02.07 Galvanizing

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

4.03.00 Tolerance

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



seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

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

When all tests to be performed in the Successful Bidder's shop under the terms of this contract have been successfully carried out, the steelwork shall be accepted forthwith and the Owner/Consultant shall issue an acceptance certificate, upon receipt of which, the items shall be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

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

4.05.02 Marking

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

- 4.05.03** The Successful bidder shall submit periodic test reports of all materials procured and used such as raw steel, paints, electrodes, colour coated sheets, poly carbonate sheets, sheeting fixtures, bolts, nuts & washers etc. The test reports shall indicate conformance to specifications / IS codes etc.

The Successful bidder shall submit test reports for all welds carried out at shop such as UT and RT reports, shall also be submitted along with each inspection call, covering structures offered for inspection.





DFT record of paint applied measured at random covering structures offered for inspection.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 NOT USED

5.02.00 After Award of Contract

After award of the Contract the Successful Bidder is to submit the following:

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



Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: VII

**GUIDELINE
FOR
ERECTION OF STRUCTURAL STEELWORK**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: VII
Erection of Structural Steel Work



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	WORKMANSHIP	4
4.00.00	TESTING AND ACCEPTANCE CRITERIA	10
5.00.00	INFORMATION TO BE SUBMITTED	14
6.00.00	MISCELLANEOUS GUIDELINES	15





**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: VII

**GUIDELINE
FOR
ERECTION OF STRUCTURAL STEELWORK**

1.00.00 SCOPE

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

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder

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

- a) The Bidder shall provide all construction materials and the Successful Bidder shall provide all transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Owner/Consultant. If necessary, suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets any defect observed in the foundation shall be brought to the notice of the Owner/Consultant. The Successful Bidder shall fully satisfy himself





regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

- e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Owner/Consultant.
- f) Painting of the erected steel structures if required by the Contract.
- g) All minor modifications of the fabricated steel structures as directed by the Owner/Consultant including but not limited to the following:
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size bolt if required.
 - iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting shall be permitted only at the discretion of the Owner/Consultant.
 - v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.
 - vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
 - vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
 - viii) Carry out tests in accordance with this Specification if directed.

2.02.00 Work by others

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

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

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





- IS-456 : Code of Practice for plain or reinforced concrete
IS-7205 : Safety Code for erection of Structural Steel work
IS-12843 : Tolerance for erection of Steel Structures

2.04.00 Conformity with designs

The SuccessfulBiddershall erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the Owner/Consultant. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Owner/Consultant.

2.05.00 Material

2.05.01 General

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

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

2.05.02 Materials to conform to Indian Standards

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

2.06.00 Storage of materials

2.06.01 General

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

2.06.02 Yard





The SuccessfulBiddershall have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which shall be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments.

The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

2.06.03 Covered Store

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

2.07.00 Quality Control

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

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

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

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

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





3.01.02 Method and sequence of erection

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

3.01.03 Temporary bracing

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

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

3.01.04 Temporary floors for buildings

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

3.01.05 Setting out

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

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

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

3.01.06 Field bolting





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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

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

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

a) Turn-of-nut method

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

TABLE - I

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

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





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

b) Torque Wrench tightening

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

TABLE - II

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

NOTE :

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

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

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

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to



be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 Field Welding

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

3.01.08 Holes, cutting and fitting

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

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

3.02.00 Drifting

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

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

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

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

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert





supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Owner/Consultant or shown on the drawings.

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

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

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

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

3.04.00 Painting after erection

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

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

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

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

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





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

3.05.00 NOT USED

3.06.00 Final cleaning up

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

3.07.00 Safety Measures during Erection

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

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

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

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

4.01.01 Stiffness Test

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





this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

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

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

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

4.01.03 Structure of same design

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

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

4.01.04 Repair for subsequent test and use after strength tests

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

4.02.00 Tolerances





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

Component	Description	Variation Allowed
I)	For Buildings Containing Cranes	
i)	Main columns	
	a)	
		Shifting of column axis at foundation level with respect to building line
	i)	In longitudinal direction
		i) ± 3.0 mm
	ii)	In lateral direction
		ii) ± 3.0 mm
	b)	
		Deviation of both major column axis from vertical between foundation and other member connection levels :
	i)	For a column upto and including 10M height
		i) ± 3.5 mm from true vertical
	ii)	For a column greater than 10M but less than 40M height
		ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	
		For adjacent pairs of columns across the width of the building prior to placing of truss.
		± 9 mm on true span.
	d)	
		For any individual column deviation of any bearing or resting level from



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

			levels shown on drawings.	± 3.0 mm
		e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
ii)	Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
		b)	Lateral displacement of top chord at centre of span from vertical plane	1/250 of depth of truss or 20 mm whichever running through centre ever is the least of supports.
iii)	Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
		b)	Deviation to crane rail gauge	± 3.0 mm
		c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
		d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
iv)	Setting of expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C.	

The coefficient of expansion or contraction





shall be taken as 0.000012 per Deg.C per unit length.

II. For Building without Cranes

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

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

4.03.00 Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Consultant shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract. Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 NOT USED

5.01.01 Tentative Programme

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

5.01.02 Constructional Plant and Equipment, Tools, Temporary Works & Manpower(after award of contract)

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

5.01.03 Erection yard(after award of contract)





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

5.02.00 After award of the Contract

After award of the contract, the successful bidder shall submit the following :-

5.02.01 Detailed Programme

The successful bidder shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

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

6.00.00 MISCELLANEOUS GUIDELINES

SAFE ERECTION PRACTICE

(a) DO'S

- (1) Carry out erection only after structures are thoroughly inspected and cleared.
- (2) Start erection from braced bay.
- (3) Ensure proper packing below the columns to have correct levels (to be checked by survey schemes)
- (4) Ensure proper anchoring of column base by tightening of all anchor bolts.





- (5) Ensure that guying is done at $2/3^{\text{rd}}$ height in 3 directions 120degree apart.
- (6) Ensure that guy ropes are fully tight and anchored. Size of the guy rope should be adequate to take loads
- (7) Provide temporary bracing wherever needed.
- (8) Outstanding of flanges of beams /columns are to be protected against local bending at location of slinging during erection.
- (9) Ensure that cross beam/bracings are erected only after the cleats/gussets are fully welded.
- (10) Do the welding of cross beams with cleats, only after ensuring all bolts are in position and are tightened fully.

(b) DON'TS

- (1) Don't leave the structures without proper guying in all directions till they are braced.
- (2) Don't miss to anchor properly at the base of columns with anchor nuts fully tightened.
- (3) Don't use manila ropes in place of steel ropes for guying.
- (4) Don't support the cross beams with temporary jigs. Ensure all the bolts are provided and tightened.
- (5) Don't use bracings/tie members for fixing lifting tackles/diversion pulleys/cable trays to avoid damages due to erection loads.
- (6) Avoid indiscriminate cutting/notching of erected and loaded structures.
- (7) Don't use column bases for anchoring guy ropes of structures.

GENERAL INSTRUCTION FOR WELDING

The Contractor shall work out welding procedure for the structures at his own responsibility and submit for Owner's/ consultant's information, considering the following factors.

- a) Specification and thickness of steel.
- b) Specification of electrode or/and base wire.
- c) Welding process (manual arc welding, submerged arc welding).





- d) Type of structures to be welded (thickness of components meeting at a joint).
- e) Pre and post heating requirement.
- f) Preparation of fusion faces.
- g) Sequence of welding.
- h) Weather condition.
- i) Use of jigs and fixtures etc.
- j) Type of non-destructive testing to be carried out.
- k) Inspection procedure to be followed.
- l) Design requirements of the joints.

Welding of any load bearing structure shall be carried out only by the person who has passed welder's qualification as per IS: 7318 (Part-I).

Contractor shall employ competent supervisors, exclusively for welding works, to ensure that the standard of workmanship and quality of materials comply with requirements of this specification.

All metal arc welding shall be carried out as per IS:9595-1996

Submerged arc welding of mild steel and low alloy steel shall be as per IS:4353-1995

Electrode shall conform to as specified elsewhere.

Purchaser may at his own discretion order periodic tests of the Welders and/or of welds produced by them. Such tests shall be at the expense of the Contractor.

Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

Low Hydrogen electrodes and flux for submerged welding shall be dried at 250°-300° C for one hour in drying even before use.

For suitability of wire flux combination, procedure test shall be carried out as per IS: 15977-2013 if so required.





Welding shall be done by electric arc process. Generally submerged arc, automatic & Semi-automatic welding shall be employed. Only where it is not practicable, manual arc welding may be resorted to. In case of manual arc welding, recommendations of electrode manufacturer are to be strictly followed.

After completing each run of weld, all slag should be thoroughly removed and surface cleaned before starting the next run of weld. The weld metal as deposited (including tack welds if to be incorporated) shall be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and consistent contour and uniform appearance.

Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method, which does not cause grooving and other surface defects on the weld or on the parent metal.

All butt welds shall start and end with run-on and run-off plates. All such plates shall be carefully trimmed off by gas cutting after welding is over.

Fillet welds shall not be stopped at corners but shall be returned round them.

If butt weld is to be ground flush with the surface of the member as per drawing. Adequate reinforcement shall be built up and then the same shall be chipped off and ground flush. The grinding is to be done in the direction of stress flow till the transverse marks are eliminated.

Welding shall not be done under such weather conditions, which might adversely affect the efficiency of the welding and arc-strikes on parent surfaces of structures shall be strictly avoided.

Manipulators shall be used wherever necessary and shall be designed to facilitate welding and ensure that all welds are easily accessible to the operators.

Stress relieving after welding shall be done if especially called for in the drawing or specification. Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

CONTROLS IN WELDING

The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures shall be as follows and shall be conducted by the contractor at his own cost. Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

a) Visual Examination

All welds shall be 100% visually inspected to eliminate the following defects like Presence of undercuts, Visually identifiable surface cracks in both welds and base metals, Unfilled craters, Improper weld profile and size, excessive reinforcement in weld, Surface porosity etc.

b) Dye Penetration Test (DPT)

This shall be carried out in accordance with IS: 11732 – 1995, used for steel castings, for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following like Surface cracks, Surface porosity. Severity Level 3 shall be considered for acceptance.

c) Ultrasonic testing

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by purchaser, to detect the following like Cracks, Lack of fusion, Slag inclusions, Gas porosity.

All butt welds shall be tested for 100 % length by Ultrasonic tests and report shall be submitted.

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-96 Chapter -6: Part F.

Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and Gamma-Ray Examination)

This test shall be conducted to a minimum of 2% of length of welds of each element of each butt joint for welds made by manual or semi- automatic welding and 1 % of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by purchaser to detect the following defects like gas porosity, slag inclusions, lack of penetration, lack of fusion, cracks.

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWS D1.1-96 Part E.

Any surface irregularity like undercuts, craters, pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than $0.75 \times$ focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.



Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

ACCEPTABLE LIMITS OF DEFECTS IN WELD

Limits of Acceptability of welding defects shall be as follows.

a) Visual inspection & Dye Penetration Test –

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 6.9 & clause 6.10 of American National Standard ANSI/AWS D1.1-96 or equivalent Indian Standards for statically as well as dynamically loaded structures respectively.

b) Ultrasonic Testing –

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 6.13.1 & clause 6.13.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

c) Radiographic testing –

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clauses 6.12.1 & 6.12.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

RECTIFICATION OF DEFECTS IN WELDS

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

- a) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.
- b) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.
- c) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.



Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: VIII

**GUIDELINE
FOR
ROADS AND DRAINAGE**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: VIII
Roads and Drainage



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	GENERAL	1
3.00.00	EXECUTION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	7



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: VIII
Roads and Drainage**



**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: VIII

**GUIDELINE
FOR
ROADS AND DRAINAGE**

1.00.00 SCOPE

This specification covers all work required for the construction of R.C.C road including box-cutting, edging, Subgrade, sub-bases preparation, RC slab etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 All the required roads within the battery limit of Chimney Package, shall be under the scope of the bidder including formation of sub-grade, sub-base and laying of RCC. All the required roads in the plant area within the battery limits of Chimney package and connecting the same with the plant main roads will be executed by respective successful bidder. Approach roads to all the buildings, structures, facilities for this Chimney package shall be provided by the successful bidder.

Work to be provided for by the Successful Bidder

The work to be provided for by the Successful Bidder, unless specified otherwise, shall include but not be limited to the followings:

- a) Furnish all labour, supervision, services, tools and plants, transportation etc. required for the work. All materials and equipment shall be supplied by Seller.
- b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.
- c) To carry out and submit to the Owner/Consultant results of tests whenever required by the Owner /Consultant to assess the quality of work.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

2.02.00 Work to be provided for by Others

No work under this specification shall be provided for by any agency other than the Successful Bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.
2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.
3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.
4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.
5. IS:2212 Code of Practice for Brickwork.
6. IS:783 Code of Practice for Laying of Concrete Pipes.
7. IRC:15 Code of practice for construction of Concrete Pavement.
8. IRC:58 Guidelines for the Design of plain jointed Rigid Pavement.
9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Owner/Consultant shall be followed.

2.04.00 Conformity with Designs

The Successful Bidder shall carryout the work as per the Bidder's drawings which are approved by the Consultant and/or the Consultant's instructions.

2.05.00 Materials to be Used

2.05.01 General





All materials required for the work shall be of best commercial variety and as approved by the Owner/Consultant.

2.06.00 Quality Control

The Successful Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Owner/Consultant. Permitted tolerances for road works are described hereinafter.

2.07.00 Concrete Road and Rigid Pavement.

Plant Roads:

Access within the plant site shall be provided by a system of roadways. All roads within this Chimney package are RCC roads only including approach roads to the buildings/structures.

All building shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement. Access roads shall also be provided to areas such as transformer areas, steam generator Area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

The sub base over the well compacted subgrade of all plant service roads within the battery limit of Chimney package will initially be made of well graded granular material like locally available crushed stone as per IRC-63 and 100mm DLC with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement.

All Roads where there is heavy vehicle movement shall be of RC concrete roads with hard RC shoulder.

All roads within battery limit of Chimney package shall have rectangular RCC side drain along both sides.

All RCC Roads shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice and MOST specification (MORT&H) for movement of heavy equipment.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design shall be laid over 100mm DLC on a crushed stone sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

All the roads inside the plant area shall be of reinforced cement concrete of minimum 250 mm thick.





The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design shall be laid over 100mm DLC on a crushed stone base/sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size. A separation layer of 125micron thick impermeable Plastic sheeting shall be provided below the RCC slab.

The width of the carriage, shoulder and drains shall match with the existing connecting roads.

All the roads shall be constructed before start of construction activities for buildings and shall again be repaired / made good after completion of construction of activities i.e at the time of handover / project.

All type of roads shall have a minimum turning radius as per relevant IRC codes (IRC-38).

Boulders shall be provided alongside of all type of roads near equipment which requires protection. Spare duct bank shall be provided under all type roads spaced at 100m intervals.

Signs shall be provided for vehicle management and shall meet the indian standards. All signs shall be dual worded in both English and the local indian language. Finished top (crest) of roads shall be as per CEA guide lines. Geometric design of road shall be in accordance with IRC: 73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

The shoulder shall be laid with slope of 1 in 30.

On either side of roads, open drains shall be provided. Minimum clear width of drains shall be 600mm or the connecting drains whichever is higher..The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. All service and utility lines crossing the roads shall be taken through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast in place RCC box culverts.

No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The roads must be designed for the heaviest equipment of the plant and before designing the CBR test to be carried out. Road shall be designed as per IRC & MOST standards. (MORT&H).



The Cross section for Concrete road in general shall be as follows:

- i) The Sub-grade, whether in cut or fill shall be well compacted to utilize its full strength. The Sub-grade shall have no soft spots or voids and undulations and shall be well compacted to achieve a minimum 95% dry density.
- ii) crushed stone sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.
- iii) 100mm thick dry lean concrete (DLC).
- iv) A separation membrane shall be used between concrete slab and the sub base. The membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases.
- v) Pavement of 250mm thick M35 mix, with double mat reinforcement of 10tor @ 200 c/c both ways or as per the design whichever is higher.
- vi) The drainage system shall be designed for precipitation intensity of 100mm per hour.

The above specified description is minimum and indicative and the successful bidder has to design and provide roads as per actual functional requirements and design criteria stipulated in relevant codes.

The detailed methodology for construction of concrete /rigid pavement including construction and expansion joint shall be prepared by the successful bidder for approval of Owner.

2.08.00 Road Side Drains

2.08.01 Formation of Drains

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 125 mm or as per design considerations whichever is higher. RCC box culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain shall have screed concrete with 12mm blue metalchips in M20 and smooth neat cement finish over screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The slope of the drain shall be 1:1000 longitudinally in general. However, discharge velocity shall be within non-silting & non-scouring condition.

2.09.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Owner/Consultant after clearing the





site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable. The top level of the Culverts shall match with the top level of road.

2.10.00 Shoulders

The sub grade shall be compacted well and the sub base shall be 230mm consolidated thickness of stone boulders/ soling as per specification over which P.C.C (M20) shall be laid to required thickness. The level of the shoulder shall be in line with the road top level or at higher level based on the location which will be decided during detailed engineering. Necessary chutes if required to the adjoining drain shall be provided.

2.11.00 Kerbs

P.C.C (M20) Kerb for full depth of the pavement shall be provided on both sides of carriage way of concrete roads. Kerbs shall be laid and set in place before completing the concrete wearing surface as well as the concrete wearing surface of shoulder. Setting shall be done in mortar where so specified. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of shoulder if the shoulder is at higher level of the road. Where the road edge forms a curve, the kerbs shall follow such curve. Gaps may be left as shown in drawings or as may be required to provide for drainage. They shall be fixed true to line and level and secured in position by approved means.

The Kerbs shall be painted as per IRC- 35 (latest edition).

3.00.00 EXECUTION

3.01.00 NOT USED

3.02.00 NOT USED

3.01.03 Relation with Water Supply Pipeline

Unless specifically cleared by the Owner/Consultant, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.02.00 Manholes and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water-tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Consultant. The covers shall be close fitting so as to prevent gases from coming out.

3.03.00 NOT USED

3.04.00 NOT USED

3.05.00 Cement Concrete (Plain and Reinforced)

Shall be as laid down in "Guideline for Cement Concrete (Plain and Reinforced)" Vol: II-B- Section: I - Part – A Sub Section - IV.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Successful Bidder as per direction of the Consultant. No extra payment shall be made for such tests.

4.02.00 NOT USED

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: A

SUB SECTION: IX

**GUIDELINE
FOR
PROPERTIES, STORAGE AND HANDLING OF
COMMON BUILDING MATERIALS**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part A; Sub Section: IX
Properties, Storage and Handling of
Common Building Materials



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	MATERIALS	1
3.00.00	STORAGE AND HANDLING OF MATERIALS	5



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part A; Sub Section: IX
Properties, Storage and Handling of
Common Building Materials**



**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: IX

**GUIDELINE
FOR
PROPERTIES, STORAGE AND HANDLING OF
COMMON BUILDING MATERIALS**

1.00.00 SCOPE

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 MATERIALS

a) Bricks

- i) Common Burnt Clay Bricks : Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws warpage or nodules or free lime, having a frog 100mm in length 40 mm in width and 10mm to 20mm deep on one of its flat sides and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc.

Compressive strength shall be as per table-1 below. The bricks, when tested, shall have a minimum average compressive strength for various classes as given in Table-1 below. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any brick tested exceeds the upper limit for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table-1 for the purpose of calculating the average compressive strength.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

The average value of water absorption of bricks when tested shall not be more than 20% by weight.

All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The rating of efflorescence shall not be more than 'moderate'.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up to the specification and defective bricks shall be removed immediately from site at the Bidder's own cost.

TABLE-1

Class Designation	Average compressive strength			
	Not less than			
	N/mm ²	(kg/cm ²)		
12.5(125)	12.5	(125)		
10 (100)	10	(100)		
7.5 (75)	7.5	(75)		
5 (50)	5	(50)		
3.5 (35)	3.5	(35)		

- ii) Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Lime Bricks (flag Bricks) shall conform to IS 12894. The dimensions of the Fly ash bricks shall be 190x90x90mm. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with frog on one flat side and without frog on other flat side. Fly ash shall conform to IS 3812. The average compressive strength shall conform to class 5 as given in the table above.

Note : Fly ash bricks will be operated only for non-load bearing walls and above ground level.

Sand : Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime : Lime shall conform to class 'C' hydrated lime of IS 712

Additives : Any suitable additive considered not detrimental to the durability of bricks may be used.



Alternatively Lime may be replaced by Cement in manufacturing of Fly ash bricks. The cement shall be blended at the rate of 8 to 12%.

- iii) **Mechanised Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plat by appropriate proportion of fly ash and lime/cement. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and the frog shall be of 100/80 mm in length, 40 mm width and 10 to 20 mm deep on one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

b) Stone

For all concrete works Blue Granite Metal shall only be used.

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion and for laterite this percentage is 12%. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Bidder and approved samples shall be retained by the Engineer for comparison of bulk supply. The compressive strength of common types of stones shall be as per Table below.

TABLE-2

Type of stone	Maximum Water Absorption Percentage by weight	Minimum Compressive Strength kg/sq.cm
Granite	0.5	1000
Basalt	0.5	400
Lime stone(Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Laterite(Block)	12	35

c) Lime

Lime shall be stone lime and conform to the specification Building Limes - IS: 712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaken with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) Cement

Cement used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The Bidder shall submit the manufacturer's test certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Bidder is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Bidder. The Bidder shall also have no claim for this type of suspension of work.

e) Coarse Aggregates

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) Sand

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand





shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

Generally River sand shall be used for all the works. In case of scarcity/non-availability of River sand, M-Sand may be used at the discretion of the Engineer-in-charge at site.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS: 226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432 Cold twisted steel bars shall conform to IS: 1786. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanised. All reinforcements shall be Corrosion Resistant Steel(CRS).

3.00.00 **STORAGE AND HANDLING OF MATERIALS**

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

c) Lime

Lime shall be stored in weatherproof sheds.

d) Cement

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Bidder and shall be removed from the site immediately.

e) Coarse and Fine Aggregates

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) Reinforcement

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.





**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: B

SUB SECTION: I

**GENERAL SPECIFICATION AND DESIGN CRITERIA OF
CHIMNEY – CIVIL & STRUCTURAL WORKS**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part B; Sub Section: I
General Specification & Design Criteria
of Chimney – Civil & Structural Works**



**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GENERAL	1
2.00.00	CODES AND STANDARDS	11
3.00.00	GRADES OF CONCRETE & STEEL	12
4.00.00	DESIGN CRITERIA	12
5.00.00	ANALYSIS	14
6.00.00	COMPONENT DESIGN CRITERIA	15
7.00.00	WIND TUNNEL TEST	27



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part B; Sub Section: I
General Specification & Design Criteria
of Chimney – Civil & Structural Works**



SECTION: I

PART: B

SUB SECTION: I

GENERAL SPECIFICATION AND DESIGN CRITERIA OF CHIMNEY - (CIVIL & STRUCTURAL WORKS)

1.00.00 GENERAL

1.01.0 SCOPE OF WORK

The Works as detailed hereinafter pertaining to RCC Bi-Flue Chimney for the presently operating thermal power plant having two units of 500 MW capacity each, in Tuticorin, Tamil Nadu for NLC Tamil Nadu Power Limited (NTPL). Since new FGD plant is being envisaged, the new Chimney construction is required.

- All Civil and structural works for RCC Bi-flue Chimney 150M high with internally lined (borosilicate) steel flues enclosed by RCC Wind Shield to suit MOEF norms with Rack & Pinion Elevator.
- Other Auxiliaries, Internal Steel Platforms, External RCC Platforms, ladders, Rack & Pinion elevator etc.
- Structural steel staircase upto the top most internal platform and from there cage ladder to roof of the chimney
- Duct supporting arrangements within the battery limits as per functional requirements
- Electrical-cum-C&I building / Analyzer shelter to accommodate extractive type analyzer Panels, Data loggers / PC, DB and other necessary accessories. This will be a RCC framed-structured single-storey building (of adequate size to meet the electrical and C&I functional / layout requirements as per technological requirement) with RCC roof. This building shall be provided to satisfy all functional and operational requirements of Electrical / C&I systems as specified elsewhere.
- RCC Approach Roads / Paving (as required) along with Street Lighting.
- Service Drains as necessary.

The Reinforced Concrete Bi-flue Stack of 150M high shall comprise of two nos. internally lined (with Borosilicate) steel flues enclosed by a wind shield of reinforced concrete shell to suit MOEF norms with R&P Elevator.





The steel flues shall be vertically supported at top & at intermediate levels (minimum four platforms) and horizontally restrained on steel platform at intervals satisfying all functional requirements. The steel platforms shall be supported on reinforced concrete shell wind shield. The suspended position of the steel flues shall be connected to the bottom supported position of the flues by expansion compensator so as to compensate for the large thermal movements of steel flue.

The scope of this work shall consist of, but not limited to, the design and construction of reinforced concrete windshield, foundations, Borosilicate lining, associated pipe works, stairs, cage ladders, rack & pinion type elevator, external and internal platforms, walkways as specified or required for operation and maintenance, access doors, MS handrails, steel fittings, fixtures, inserts including fabrication, galvanizing (wherever required) and erection of associated steel work and other chemicals on the completed structures etc. all complete as per functional requirements and as per directions of Owner.

The scope of work under this specification shall include providing engineering design and drawings, all labour, supervision, materials, shuttering and scaffolding including slip form, construction equipments including cranes, hoists, batching plants etc. tools and plant, supply and transportation of all incidental items not shown or specified but reasonably implied for successful completion of the work. The nature of the work shall generally involve foundation, excavation, dewatering, shoring and strutting, backfilling around underground structures and plinth filling, sand filling, disposal of surplus soil outside plant boundary and as directed by the Engineer in charge, concreting of grade as specified, formwork including automatic climb form, fabrication, galvanizing (wherever required) and erection of steel structures and inserts, finishing anchor bolts etc. as required.

The successful bidder shall furnish the Slip form design including all detailing and analysis for Owner / Consultant for approval before taking up the shell work at site.

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

The scope of this specification also includes but not limited to erection / installation, supervision, including unloading, storage and handling at site, site testing, commissioning, and other erection services to ensure trouble free operation and commissioning of the plant as per mechanical requirement.

The Successful bidder shall carryout, at his own cost, model test of chimney in wind tunnel in an approved laboratory to investigate the aerodynamic behavior of the chimney. Effect of adjoining structures such as boilers, cooling tower etc. on magnifying wind loading on the chimney shall be studied in a wind tunnel before the designs are finalized. A provision of 10% increase in the wind load



forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs. Worst of the forces calculated as per as per codal requirements and forces obtained from wind tunnel study shall be considered as design forces for final design of shell and foundation. Wind tunnel study has to be done in any one of the following approved labs – SERC-Chennai, IISc-Bangalore and IIT-Kanpur and the study report shall be got approved by the owner / Consultant. The model test shall be duly witnessed by the owner and the Consultant.

The flue ducts shall be entering as per layout given by FGD Package vendor.

Refer to Vol-II-B Sec-I - Part B - Sub Section-II of this specification for Guideline for Construction of RCC Bi-Flue Chimney.

The area around Chimney for 5m width shall be RCC paved except for the portions if already paved. Wherever existing paving is dismantled during construction activities shall be restored with RCC paving at the possible locations.

1.02.00 General parameters of the chimney

Total height of the chimney above FFL	:	150 m.
RCC Wind shield (shell) enclosing Two steel flues, one for each Boiler.		
No. of Boilers.	:	Two
Particulate emission	:	30 mg/Nm ³ (approx)
Volume of Gas (at NTP 0 ° C and 1.013 bar)	:	734.791 Nm ³ /sec * (per flue)
Temperature of flue gases.	:	60° C *
Acid dew point	:	75° C *
Flue gas pressure at Chimney entry level.	:	10 mm WC * (To be considered as NIL for stack sizing)
Stack Exit velocity	:	Maximum 18.3 m/s (With Borosilicate block lining as per latest EPRI guidelines)
Note: The parameters marked with asterisks (*) are indicative only.		
Inlet-duct Center line elevation.	:	During Detail
Duct opening Dimensions.	:	Engg. Stage
Minimum top internal shell diameter.	:	To be decided by Bidder
Minimum bottom internal shell diameter	:	To be decided by





Bidder

** The bidder shall use the borelog data of Owner's Existing Soil Investigation Report for reference purpose. Moreover, bidder is at liberty to carryout suitable number of borehole tests at site to assess the pile capacity values for pile foundations and the Net Safe Bearing Capacity values for open foundations prior to quote. After contract award, the design of foundations shall be carried out as per the provisions of IS-456 & IS-2911. The design, type, size, depth of the foundation shall be based on the approved soil investigation report of the successful Bidder/Owner's soil investigation report whichever is conservative.

1.03.00 The windshield shall be of RCC construction. Two nos. of steel flues shall be housed within the windshield. Flues shall be supported on the top of platforms. Platforms shall be provided at regular interval. The flue ducts shall be entering as per layout given by FGD Package vendor.

1.04.00 All internal platforms shall be supported on R.C. shell of the wind shield. Internal structural steel staircase for access to all platforms shall be provided. Rolling shutter (electrically operated) and one Steel Door at grade floor level shall be provided for access into the windshield and on to the platforms. All doors like inspection/ maintenance doors shall be as per IS code / environment regulation.

1.05.00 Natural Ventilation within the windshield shall be provided as required.

1.06.00 **Process Criteria for Wet Chimney**

- i) Treated flue gas from the absorber shall be discharged through the chimney flues. The wet flues of chimney shall be suitably lined. The flue duct shall be lined with 51 mm thick Borosilicate glass blocks . External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium sheet. The design & construction of steel chimney liners shall be based on the guidelines of EPRI Revised Wet Stack Design guide.

For bypass condition, existing 275m high Chimney will be utilized.

- ii) Wet Chimney Condensate Collection System

To avoid the carryover of the condensate/acidic dews/water droplets/ gypsum coming out of the wet chimney a condensate collection system shall be provided. Design of the condensate system should be such that the liquid condensate film near the exit of the stack is collected in the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the nearby area.

- iii) Wet stack flow model study





A wet stack flow model study shall be performed by the Contractor or by the Sub-Contractor (who satisfy the requirements as specified in Vol II A. Section III Annexure-1 Acceptance criteria for Sub-contractors) for each unit with a wet stack installation where there does not exist an identical or mirror image installation that has already had a wet stack study performed for this project. A wet stack model study shall consist of the following:

- a) Condensation calculations.
 - b) Minimum 1:12 scale physical flow model for liquid collector design.
 - c) Computational flow model for plume downwash analysis.
 - d) Physical or computational flow model for CEMS elevation flow performance.
- iv) Liquid collectors shall be designed and developed experimentally using a physical model. The model shall begin at the outlet of the absorber mist eliminator(s), including the absorber outlet and ducting, the stack breaching duct and a minimum of three (3) diameters of the stack liner above the top of the stack breaching duct. Physical model shall include any internal devices that may affect the gas flow, such as structural members, flow controls, and expansion joints. Liquid collectors shall be located where needed in the absorber outlet, the ductwork between the absorber outlet and the chimney liner, in the chimney liner, and in the exit nozzle. These collectors shall collect liquid from surfaces, prevent re-entrainment, and guide the liquid to locations where it can be drained out of the system and prevent the discharge of droplets from the top of the stack that are large enough to drain out to the ground before evaporation.
- For the model studies, sharing of the necessary input and result details with the FGD vendor shall be considered for reiteration of model study and finalizing the ducting and flue can design.
- v) A common Nickel based alloy material storage/neutralizing tank for both the units of storage capacity of as per mechanical requirement of condensate from both the flues shall be provided complete with neutralizing chemicals dosing, mixing and preparation system. The neutralized condensate shall be pumped to common drain system by pumps as per mechanical requirement, complete with valves, piping and fittings, level control and monitoring etc. All the equipment, piping and fittings in contact with the condensate shall be of suitable material for the operating duty. The condensate collection system in this package includes condensate from FGD outlet up to flue can top.
- vi) All chimney condensate collection equipment shall be easily accessible for O&M. The design of the stack condensate collection system including that are covered under model study shall be provided by successful bidder. The Laboratory where the condensate collection



study is to be conducted is to be approved by the Owner/Consultant and report shall also be submitted for approval by Owner/Consultant.

vii) Chimney Liner Materials

All materials shall conform to IS Codes. However, the following shall apply: The flue duct shall be lined internally with Borosilicate glass blocks of 51mm thick. External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium sheet over insulation.

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. The Insulation shall consist of 6 layers of insulation material (resin bonded rock wool) each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. Blanket type insulation shall not be used. This shall be protected from the elements by wrapping with 2mm thick Titanium/C-276 sheet cladding. Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings by the contractor shall be carried out.

The thickness of Borosilicate shall be 51mm. The lining material should withstand minimum 200°C for continuous operation of maximum 30minutes duration.

1.07.00

SPECIFICATION FOR BOROSILICATE LINING

Borosilicate Glass Block Internal lining material, for the flues for the entire height including the lining of flue gas duct up to chimney inlet flange (including transition duct)..

- i) Borosilicate Cellular Glass Block, 51 mm thick, as required
- ii) Epoxy Primer
- iii) Adhesive membrane
- iv) Stack condensate collection system to avoid the carryover of the condensate/acidic dews/water droplets coming out of the stack.

Borosilicate Blocks:

The lining system shall use closed cell borosilicate glass blocks with the following physical properties:

- i) A coefficient of linear thermal expansion not greater than $5.5 \times 10^{-6}/^{\circ}\text{C}$, as per ASTM E228
- ii) Compressive strength of at least 1.38 Mpa / 1.1 N/Sq.mm as per ASTM C.165
- iii) Flexural strength of at least 0.62 Mpa / 0.8N/Sq.mm as per ASTM C.203/C.240



- iv) Thermal conductivity of 0.087 W/m²K at a mean temperature of 38 °C as per ASTM C177 and ASTM C518

Adhesive membrane

The adhesive membrane shall be a 2-component urethane asphalt mastic having excellent elastomeric properties and be acid & heat resistant. The adhesive membrane shall be applied in between and behind the blocks in a 3.2mm thick layer ensuring a proper bond and adhesion. The adhesive membrane shall have the following properties.

- i) Tensile strength at 23° C of 1.0 N/mm² as per ASTM D.412
- ii) Elongation at 23° C of 147.0 % as per ASTM D.412
- iii) Moisture vapor transmission of 0.0048 Perm inches as per ASTM C.96 Method E
- iv) The adhesive shall show no slump after 5 hours conditioned at 60°C with a film thickness of 3/32" as per ASTM 6511, standard test methods for solvent bearing bituminous compounds, section 12 behavior at 60°C.

Specification of primer

Primer to be applied on steel substrate receiving borosilicate glass block lining system shall have the following properties including thickness, physical & chemical properties.

- i) The primer shall be a high performance epoxy primer. the primer shall be applied in 1 layer with a WFT of 3 to 5 mils
- ii) The primer shall be applied either by rolling or spray gun Welds and joints shall receive an additional layer of primer by brush prior to rolling or spraying
- iii) The solids by volume of the high performance epoxy primer shall be no less than 50%
- iv) The bonding of the primer to the steel shall be at least 1400 psi. as per ASTM D4541

Specification for surface preparation for steel substrate.

- The steel surface shall be grit blasted to a cleanliness of SA 2 1/2 and approved by the supplier of the lining system
- The substrate shall thereafter be primed using a high performance epoxy primer within a short time window approved by the supplier

Wet stack properties of the lining system

The lining system (borosilicate glass block and adhesive) shall be tested for its wet stack surface properties by an independent approved institute, subject to acceptance by the Purchaser, and has during such testing been shown to allow, without any significant re-entrainment of flue gas condensate, a flue gas velocity of 18.3 m/s.

Bidder shall provide a project specific "Wet Stack" study, performed by an independent approved institute, subject to acceptance by the Purchaser,

indicating the correct placement and design of liquid collection gutters and liquid drains to ensure minimization of liquids and condensates entering the chimney.

Installation of Borosilicate block lining system

Surface Preparation & Surface Cleaning

Lining of the chimney shall include necessary cleaning, surface preparation and all arrangements for man material shifting, approach facilities, inspection etc.

Mixing of Adhesive Membrane

- The Adhesive membrane shall be mixed according to the direction for the product use in the correct mixing ratio.
- The temperature for mixing the main material and hardener shall be about 24 deg C.
- Appropriate mixing method shall be used for equal mixing and should be blended for the required appropriate time.
- Sufficient time shall be allowed for curing

Mixing machine

- Mixing machine shall be used for preparing the 2 component Adhesive Membrane on site.
- In order to ensure consistent, high quality mixing of the components of the lining system adhesive, (an) automated mixing machine(s) should be provided using a 3,200W mixer motor, with fail-safe protection against the operator error of mixing the main adhesive component without its hardener.
- The mixing machine must be CE – approved.
- The mixing machine shall have thermal motor protection to minimize failure and fire risk.
- Adequate number of mixing machines shall be employed for completion of the installation works for the two units/flue cans within the scheduled time.

Mixing of Epoxy Primer

- Epoxy Primer shall be mixed according to the direction for the product use
- Mixing ratio shall be as recommended by OEM
- Epoxy Primer shall be blended by using Mechanical Mixer for the required minimum time.

Installation of Borosilicate Block

- The Adhesive membrane shall be applied as per the instructions of OEM.
- Arrange the borosilicate glass blocks such that there is no blank space between the block and surface. The adhesive should fill the side joint and flow out to the edge. The block shall completely stick to adhesive applied on the surface.
- Block whose edge is broken shall not be used.
- All the equipments and tools required to install Borosilicate Glass Block lining system including Polyethylene film, Rag, Wire brush, Plastic sink, Electric drill, Jiffy Mixer Blade, Insulated saw, Float, Paint brush, hand cleaner,

Cleansing glove, Hygrometer, Surface thermometer, white chalk, white spray etc as required shall be arranged by the bidder.

- It is important that the liner substrate be fully covered with the adhesive material to ensure that a continuous chemical- and moisture-resistant barrier is formed between the inside and outside of the flue. A nominal adhesive thickness of 3.2 mm is recommended behind and between each block. A 1.6-mm thick layer should be troweled onto the liner, as well as to the sides and back of each brick, before installation. This double-buttering technique ensures a full bond of each block to the liner and to each other. Excess adhesive material squeezed out during placement of the block should be struck clean.

Ensure the proper radial alignment of the blocks and to strike the adhesive/mastic flush with the inside surface of the liner. The surface of the block should be clean and free from smeared adhesive/mastic material. If the maximum projection or offset between bricks on the interior surface of the liner shall not exceed (3.1 mm).

Inspection

- Inspection and testing including adhesion shall be as per approved QAP.
- The mixing, curing and adhesion characteristics of the adhesive membrane shall be evaluated by applying it onto a test area of the same material and surface preparation of the substrate. Work life and initial set time may be visually observed. Cure shall be uniform.
- The installation procedure of the lining system shall be verified by installing the system on a transparent panel. Visual inspection shall be made of back, end and side joints.

Testing

- Borosilicate Lining Block should withstand Hydrolytic resistance as per ISO 719.
- The lining system manufacturer shall demonstrate a proven quality control system that monitors and documents the key physical properties mentioned in the specification.
- Bidder shall check and provide satisfactory proof to owner, that the back joint adhesive of the borosilicate lining system will not exceed its supplier recommended operating temperature during any operating condition that can occur before and after FGD system commissioning.
- The Borosilicate Block shall withstand EPRI parameters of 18.3 m/s flue gas velocity

Heat cycling resistance

- The lining system shall, through documented testing, have been proven resistant to thermal shock, for a minimum of 1000 cycles, where each cycle results in the lining surface temperature to rise from ambient temperature to 180 °C, and back to ambient temperature.
- The lining system shall also withstand occasional excursion of flue gas temperature of more than 200°C.

On site supervision and QA/QC services

- The lining system (borosilicate glass block and adhesive) supplier shall provide on-site technical support and QA/QC supervision, and shall employ

QA/QC supervisors with a demonstrated experience of at least 5 years in technical support and QA/QC supervision of the subject lining system.

Performance, safety and fire risk

- The lining system (borosilicate glass block and adhesive) shall be tested and certified for fire risk by an approved institute subject to acceptance by the Purchaser, and thorough testing as per relevant ASTM standards.

Requirement in Flues

Sample Point

- Borosilicate block primer and high nickel steel bar will be applied to sample points to make it acid resistant.
- The nozzle (Pipe tube) shall be of suitable alloy steel to withstand design operating environment.
- Nozzle shall be fully seal-welded both inside and outside of the steel duct plate. The inside weld shall be ground smooth.
- The nozzle shall be flanged and not threaded.
- The Glass Blocks shall be Cut and shaped as required to fit. The block shall be fully bonded to the exterior surface of the nozzle with adhesive membrane.

Manhole and Access doors

- Manholes/Access doors shall be modified by application of borosilicate blocks.
- High nickel alloy stop bars of 2mm thickness for protection from acidic condensate.
- Fibre gaskets shall be used for sealing.

Collection gutter

- The condensate generated in flue gas while FGD is under operation, shall be collected and discharged from bottom of the flues.
- The material of gutter including drain and base plates shall be made of suitable alloy steel to withstand design operating environment.
- All welds shall be full seal welds.
- The surfaces of the alloy materials which will be in contact with the lining system shall be blasted and primed with Epoxy Primer.
- The Glass Blocks shall be fully bonded to the alloy steel.

Puddle Flange

- Puddle flange located at the bottom of soot hopper shall be lined with High nickel alloy material for protection from acidic ash.

Expansion Joints (if any)

- Expansion joints cannot withstand the acidic flue gas during FGD operation and hence shall be provided with acid resistant elastomeric fabric bellows.

Documentation



- a) Documentation shall, as a minimum, comprise the following.
 - i) All drawings including shop drawings for the above works and supply
 - ii) O&M Manual, Installation & Instruction Manual
 - iii) Submission of comprehensive QA documentation after the completion of the lining process in the flue can.
- b) All relevant drawings/documents/data including supply of equipments, not specifically mentioned above but deemed essential for successful completion of the lining work will also be furnished/ supplied by the successful Bidder for approval.
- c) All other miscellaneous equipment and accessories required for a complete functional system which meets the intent and requirements of this specification shall also be furnished by the bidder.
- d) Condensate / acidic dews / water droplets coming out of the stack.

2.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design. The latest editions/ revision (as on the original Scheduled Date of Tender Opening) of following codes and standards along with addendums/ amendments, if any, shall be followed:

- a) IS: 456 - Code of practice for plain and Reinforced Concrete.
- b) IS: 800 - Use of Structural steel in general Building Construction.
- c) IS: 875 (Part-3) - Code of Practice for Wind Loads.
- d) IS: 1786 - Cold twisted steel bars for Concrete Reinforcement.
- e) IS : 432 - Mild steel and Medium steel Bars
- f) IS: 1893 (Part 1) - Criteria for Earthquake Resistant Design of Structures: Part 1- General Provisions and Buildings.
- g) IS: 1893 (Part 4) - Criteria for Earthquake Resistant Design of Structures: Part 4- Industrial Structures Including Stack-Like Structures.
- h) IS: 4998 - Design of Reinforced Concrete Chimneys - Criteria
- i) IS: 6533 (Part 1 & - Design Construction of Steel Chimney –





Part 2) Code of Practice

IS : 14593 Design and Construction of Bored Cast-In-Situ Piles Founded On Rocks

j) Reference may also be made to ACI: 307 "Specification for design and construction of R.C. Chimney", If some items are not covered in Indian Codes.

i) ASCE-1975 : Design and construction of steel chimney liners prepared by Task committee on steel chimney liners, Fossil Power Committee

Books:

- a) Tall Chimney - Design and Construction By S.N. Manohar
- b) Reinforced concrete chimney tower By G.M. Pinfold

3.00.00 GRADES OF CONCRETE AND STEEL

The grade of concrete for RCC shall be M-35 for all RCC structures with minimum cement content of 400 Kg/m³.

Ordinary Portland cement namely Grade 43 conforming to IS: 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) may be used with approval by the Owner. Only one grade of concrete shall be used throughout the height of the shell.

Grade of cement shall be OPC and for underground structures, it shall be minimum 5% -8% C3A content.

High yield strength deformed bars of grade Fe500 CRS conforming to IS 1786 shall be used as reinforcement. Grades /Fe500D CRS/Fe550D CRS may also be used but the design is restricted to Fe500 only.

Structural Steel sections and plates having yield stress 250 MPa conforming to IS: 2062 shall be used. Plates for steel flue shall be CORTEN-B Steel conforming to IS 2062 having yield stress 250 MPa.

4.00.00 DESIGN CRITERIA

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 IS, reference shall be made to ACI, BS, CICIND and other international standards.





4.01.00 **Loading**

4.01.01 **Dead Load**

All permanent loads due to the weight of chimney shell, internal steel platforms, external RCC platforms, linings, ladders, flue ducts, staircases, Elevator and other accessories etc.

4.01.02 **Imposed Loads**

- i) Imposed load on service platform around Chimney shell, shall be taken as 500 Kg/m^2 . Design live load during construction / erection shall be considered as 1000 Kg/m^2 .
- ii) Imposed loads from duct joining the Chimney shall be considered.

4.01.03 **Wind Load**

The wind loading shall conform to Latest version of IS 875 (Part-3). Following parameters shall be considered for assessing wind loads:

Basic wind speed = 39 m/s at 10m above mean retarding surface.

$k_1 = 1.06$ as per Table 1 of IS 875 (Part-3) (Latest) corresponding to 100 years return period

$k_3 = 1.0$

$k_2 =$ As per IS 4998 (Latest).

$k_4 =$ As per IS 4998 (Latest) and IS 875 (Part 3) (Latest).

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

Profile (diameter, thickness etc.) as well as wind forces (moment/shear etc.) at different sections/levels of chimney shall be calculated as per structural analysis conforming to requirements of IS: 4998 (Latest) and Contract Specification. Wind Tunnel study shall be carried out based on the profile of the chimney determined. Worst of the forces calculated as per codal requirements and forces obtained from wind tunnel study shall be considered as design forces for final design of shell and foundation. Wind Tunnel Study shall be conducted in any one of the following approved Lab/Institute - SERC-Chennai, IISC-Bangalore & IIT-Kanpur and the study report shall be got approved by the Purchaser / Consultant. The model test shall be duly witnessed by the Purchaser and the Consultant and get approved by Owner/Consultant.

4.01.04 **Seismic / Earthquake Load**

Calculation of earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893 (Part 4) (Latest) [Zone – II] using the



Response Spectrum Method. Material damping factor and number of modes to be considered for the analysis shall be as per recommendation in the code referred above. However in any case the number of modes shall not be less than five.

4.01.05 Thermal Effect

Thermal effect due to established thermal gradient shall be duly considered as per provisions in relevant IS code.

The temperature gradient ΔT across the shell thickness of wind shield shall be calculated as per IS: 4998 (Latest) but subject to a minimum of 30°C. The temperature stresses shall be calculated according to the procedures given in ACI – 307 and IS: 4998 (Latest).

4.01.06 Local Loads

The effect of following local loads shall be considered.

- a) Local moment produced by corbels (if any).
- b) Local moment due to platforms.
- c) Local moment due to occurrence of ovaling oscillation.
- d) Local moment produced by thermal gradient.

4.01.07 Load Combination

Various load combination for calculation of stresses shall be as under.

- I Dead load $\pm$ Wind load.
- II Dead load $\pm$ Earthquake effect.
- III Dead load $\pm$ Temperature effect.
- IV Dead load $\pm$ Wind load $\pm$ Temperature effect.
- V Dead load $\pm$ Earthquake force $\pm$ Temperature effect.
- VI Circumferential stresses due to temperature effect.
- VII Circumferential tensile stresses due to wind induced ring moment.
- VIII Circumferential compressive stress due to wind induced ring moment combined with temperature.

In Load combinations (I) to (VIII) above, dead load considered shall be with or without the weight of flue, whichever condition is more critical shall be adopted for design. Across wind loads shall be combined with co-existing along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-existing along winds loads.

Limit State Method of Design shall be followed as per Latest IS 4998.

5.00.00 ANALYSIS

5.01.00 Free Vibration Characteristics of Wind Shield

Assessment of Natural Frequencies and mode shapes shall be carried out. For this purpose the Chimney shell shall be idealized as a vertical cantilever with Lumped masses at different nodes. The nodes shall also be provided at each platform level.

The number of modes to be considered in the analysis shall be such that at least 90% of the modal mass is excited.

5.02.00 Wind Loads

5.02.01 Along Wind Load

Along wind load shall be assessed based on methods specified in latest version of IS 4998. Dynamic modulus of Elasticity of concrete as recommended in latest version of IS 4998 shall be used for evaluating the natural frequencies.

Mean drag coefficient 'CD' shall be taken and considered for the concrete shell as per IS 4998 (Latest).

5.02.02 Across Wind Loads

The across wind response due to vortex shedding of the Chimney shall be evaluated as per the method given in IS 4998 (Latest).

5.02.03 Ring Moments due to Wind

The circumferential ring moment due to wind shall be calculated in accordance with of IS 4998 (Latest).

5.03.00 Seismic Analysis

The Seismic Analysis shall be carried out as per IS 4998 (Latest) using the Response Spectrum Method according to IS 1893 (Part-4) (Latest) taking the first 5 modes (minimum) of vibration into account. 5% damping shall be considered for the analysis.

5.04.00 Chimney shall be designed without considering provision of strakes.

6.00.00 COMPONENT DESIGN CRITERIA

6.01.00 Wind Shield and Foundation

The design conditions for the concrete shell shall be as follows:

- 1) The concrete shell shall be designed for loads and load combinations as specified in IS 4998 (Latest). Limit State method shall be used for design of shell.
- 2) The concrete shell shall support all platforms, which in turn supports the flues. The beams supporting the platform shall be made to rest on the shell by making a pocket in the shell with necessary embedding/fixing arrangements. Suitable Elastomeric bearing pads shall be provided below the beams. These bearing pads shall be designed against temperature effect and horizontal shear due to seismic loads. The diameter of flue and RCC wind shield will be so chosen as to allow for sufficient clearance to accommodate essential accessories like staircase, elevator, test probes etc. The space should also ensure adequate ventilation around the flue and maintenance requirements.

Uniform concrete grade shall be used for chimney wind shield.

- 3) The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than $H/500$ where H is the total height of the windshield above top of the foundation.
- 4) The static modulus of elasticity of concrete for various concrete grades shall be taken as specified in IS: 456.
- 5) The dynamic modulus of elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS: 4998 (Latest).
- 6) Reinforcement in the shell shall be provided as per IS: 4998 (Latest). However, the maximum spacing of reinforcement shall not be more than 250 mm both ways in the shell and 300 mm for foundation raft.

For Vertical reinforcement, Minimum reinforcement shall be 0.25% of the overall concrete section under consideration. For circumferential reinforcement, minimum reinforcement shall be 0.20% of the overall concrete section under consideration subject to minimum of 4cm^2 per metre height of the stack. The circumferential reinforcement shall be placed nearer to the faces of the shell.

While providing vertical reinforcement steel in the shell, the total number of vertical bars shall be continued till such height when alternative bars can be discontinued. However, reduction of bar diameter along the height is permissible. At any section of the shell vertical bars shall be uniformly spaced. Non-uniform spacing of vertical bars is not acceptable.

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

- 7) Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. as required. The maximum width of opening shall be limited to an angle of not more than 30° subtended at the center of the concrete shell.

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

- a) IS: 4998
 - b) ACI 307
 - c) Reinforced concrete chimney and tower by G.M. Pinfold.
- 8) Suitable foundation to support the staircase shall be provided as required.
- 9) Staircase and elevator enclosures shall be provided keeping provision for a rack and pinion type electrically operated elevator.
- 10) Minimum thickness of wind-shield at top of chimney shall be 300 mm and the minimum thickness of the RCC shell at the top of base raft shall be 850mm. However, thickness of shell shall be matched with guidelines provided in IS: 4998 (Latest version).
- 11) Uniform Grade of concrete shall be adopted throughout the height of chimney shell.

6.02.00 **Steel Flue**

6.02.01 **Material**

- 1) The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length (below roof) or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. Above the roof also the liner is of AISI:316L/BS:1449 and the height of the flue shall be as per the design requirement. Acid resistant Borosilicate brick lining shall be provided at inside face of the flue.

Design of Steel Liners

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

division published by ASCE-1975.

- 2) Stainless steel liners shall be fabricated using material conforming to AISI 316L or BS: 1449. Grade of steel shall be equivalent to BS: 1449 (Part 2) 316 S.12.

At Load Bearing and Side Restraints of Flues

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

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

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

- i) Two layers of insulation, each consisting of heavy weight glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 kg/Sq.m.
- ii) A continuous filament glass cloth coated both side with flouro-elastomer having an approximate weight of 1.5 kg/Sq.m.



- iii) Two layers of PTFE (Poly Tetra Flouro-Ethylene) film of minimum thickness 0.15 mm each.
- iv) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 kg/Sq.m.
- v) The scope of providing expansion joint between chimney transition duct and FGD duct at the battery limit shall be under the scope of FGD contractor.

4) Flue Support Arrangement:

- a) The support brackets and bearing assembly shall be welded to the locally thickened portion of the flue and in turn support the flue on the support platform. The arrangement shall cater for thermal movements of liner elements in a smooth and easy manner.
- b) The support arrangement shall typically consist of the flue support shoe (which is part of the flue), flue support bracket which is connected to the shoe by a precision bolted connection. The bracket in turn is welded to a bearing assembly. The bearing assembly is later bolted to the support beams available.
- c) Suitable restraint brackets and stop plates of MS shall be provided to avoid excessive movement, and keep the different units of the bearing assembly in position.
- d) Restraint and support brackets shall also be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

6.02.02 Design

Flue size (internal diameter) shall be selected considering flue volume, head loss in duct, exit loss etc. Vibration frequency shall be maintained more than (+/-) 20% away from the fundamental frequency of the windshield. If this is not possible then a dynamic analysis shall be undertaken treating the flue and the windshield as a coupled system.

Following factors of safety shall be maintained for different load combinations:

Operating Condition	Load Combination	Minimum Factor of Safety
Normal	D+T+W/4	2.0
Abnormal Environmental	D+T+W or E	1.5





Abnormal Operation	$D+T^*+W/4$	1.333
D, W, E = Dead, wind and earthquake loads T = Loads due to temperature T* = Loads due to abnormal operating temperature		

The liner shall be designed to safely withstand service loads as well as stress induced during its handling, transport and erection. At locations where the flue is stayed, frictional forces develop due to thermal movement. These forces shall be accounted for in design of the flue. The flue liner thickness shall be determined from structural and corrosion potential considerations. However, the minimum thickness of the liner determined from structural consideration alone shall not be less than 6 mm and corrosion allowance adopted shall not be less than 4 mm and thereby minimum total installed thickness of flue liner shall not be less than 10 mm.

6.02.03 **Liner Hood / Cap**

The liner hood shall be fabricated from 6 mm thick stainless steel sheets of grade 316 L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding. This will prevent exposure of insulation from the surrounding flue gas environment. Special care should be taken to provide sufficient overlap of the stainless steel flashing cladding over the shield plate attached to the chimney roof cap. This is to ensure that adequate protection is achieved for the liner within the wind shield from the elements. All sections of the cladding / flashing shield plate shall be anchored in place with stainless steel bolts / nuts. Slot holes shall be provided to make allowances for differentials expansions/ movements. The Chimney cap shall slope towards the inside of the chimney at an angle of approximately 30° to the horizontal.

6.03.00 **Internal Platforms**

6.03.01 Internal platforms shall be provided at levels matching with the External Platforms and as required meeting all functional requirement and shall be supported on structural steel beams. Structural steel beams shall be supported on the shell (by making pockets on the shell). The platforms shall be located at approximately 40m intervals throughout the height of the chimney. Total nos. of internal platforms will be 4 nos.(minimum). Except for the roof slab, all the platforms shall be provided with MS chequered plate of min. 8mm o/p. All recesses of the intermediate platforms must be protected with hand railings of minimum 1.2m height. Handrails will consist of 40 NB pipes conforming IS: 1161 for vertical posts. Horizontal rails of 32NB will be provided at the top and at 500 mm intervals below from top, Toe guard plate with 50x6mm flat at bottom. At least three horizontal pipes will be provided for handrail.

6.03.02 The platforms shall be designed for the following loads:

- 1) Dead loads, weight of flue, Weight of lining, if supported on the platform.



- 2) Live load on the platforms during operation and maintenance @ 500 Kg/m² (min).
- 3) Construction loads.
- 4) Thermal loads.
- 5) Effect of wind / seismic loads.

6.03.03 The platforms shall also be designed to accommodate displacements caused by the thermal deformations, shrinkage and creep.

6.03.04 The steel girders supporting the platforms shall be provided with shear connector. However, for the design of plate girder the composite section of slab and beam shall not be considered. Deflection of girders shall not exceed span / 600. However, deflection for secondary beams supported on main girder may be span / 325. All the girders & beams, platforms and handrails shall be provided with 3 coats of heat and acid resistant epoxy paint over one coat of epoxy primer.

6.03.05 Corrosion allowance 2 mm (min.) shall be kept in the design of plate girders.

6.03.06 The minimum thickness of web shall be kept as 12 mm for fabricated plate girders carrying the flue load.

6.04.00 **Foundation**

Only PILE foundation shall be provided.

The bidder shall use the borelog data of Owner's Existing Soil Investigation Report for reference purpose. Moreover, bidder is at liberty to carryout suitable number of borehole tests at site to assess the pile capacity values for pile foundations and the Net Safe Bearing Capacity values for design of open foundations prior to quote. After contract award, the design of foundation shall be carried out as per the provisions of IS-456 & IS-2911.. The design, size, depth of the foundation shall be based on the approved soil investigation report of the successful Bidder/Owner's soil investigation report whichever is conservative.

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. Worst of the forces calculated as per codal requirements and forces obtained from wind tunnel study shall be considered as design forces for final design of foundation. The Foundation shall be checked for overturning and sliding considering maximum and minimum vertical load. There shall be no uplift under the foundation for any loading condition. No allowance shall be made for wind and seismic load combination. Grade of concrete for foundation shall be minimum M 35. Necessary provision shall be made in foundation design for supporting

the transition duct.

The pile cap may be treated as raft and annular raft with hollow inside is not permitted. Pile cap diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12. Minimum reinforcement shall not be less than 0.12% (of overall section under consideration) in either face and in each direction. Wind and earthquake shall be treated as normal load and no enhancement of stress is permitted on this account in soil, concrete and steel. No tension will be allowed under the foundation during earthquake and wind. Foundation will be designed for SRSS of final moments (as explained above) of along wind response and across wind response. The effect of water table shall be considered and the foundation shall be checked for overturning and sliding for minimum and maximum vertical loads. Ground water table shall be considered at finished grade level for foundation design. 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 300mm.

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

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

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

6.05.00 Outer Platforms

- 6.05.01 Outer platforms shall be of RCC. It shall be provided as per Directorate of Air Routes & Aerodromes (DARA) Circular for locating Aviation Warning Lights and for other maintenance puposes. The platforms shall be equally spaced at a spacing of 40 m (maximum). Additional platforms for sampling ports, access doors, clean out doors etc. shall have to be provided as per requirements. Total nos. of external platforms will be 4 nos.(minimum).
- 6.05.02 The minimum clear width of the platforms shall be 1200 mm and a live load of 500 Kg/m² shall be considered for design in addition to the dead loads and other incidental loads, if any.
- 6.05.03 Hand railing shall be provided all around external platforms including hood platform using 40 NB stainless steel pipes of grade 304. The spacing of railing posts shall not be more than 1500 mm center to center. The height of hand railing shall not be less than 1250 mm. There shall be three horizontal railings of 32NB about 450 mm, 850 mm & 1250 mm respectively above platform level.
- 6.05.04 32 mm dia G.I. drainage spouts shall be provided in platforms for drainage of



rainwater.

- 6.05.05 150 mm dia DI RWDC pipe (minimum two in numbers) shall be provided to carry rainwater from roof to discharge point at ground level. The number of down take pipe shall be decided as per design.

6.06.00 **Roll – Up door**

- 6.06.01 Flue duct erection opening of sufficient size considering all aspects shall be provided by the bidder. After erection, it may be covered with rolling shutter suitably.

Electrically operated rolling shutter of size 3.0m x 3.50m (minimum) shall be installed at Finished Floor level along with guides, hood, hardware, weather baffles, combination end locks and wind locks, mechanism and accessories as required for proper operation and weather protection. The complete details and specifications of rolling shutter shall conform to IS: 6248 (latest edition) "Metal Rolling Shutters & Rolling Grills". RCC ramp shall be provided for access from the road/ground level.

- 6.06.02 The door shall be installed in accordance with the details and the manufacturer's directions. When installed, the door shall be free from warp twist, or distortion and shall be lubricated and adjusted to operate freely and smoothly.

6.07.00 **Personnel / Access Doors**

- 6.07.01 A steel personnel door of size 1200mm x 2100mm shall be provided for access to the windshield at grade level in addition to the rolling shutter with RCC ramp approach.

- 6.07.02 Steel Personnel doors of size 1200mm x 2100mm shall be provided in shell for access to external platforms,, at different levels so that aviation warning lights could be approached for maintenance purposes.

- 6.07.03 One air tight Access door at roof of size 750 mm x 1000 mm in stainless steel shall be provided to cover access opening at + 145 M. floor.

- 6.07.04 The doors shall be hinged and provided with positive locking device. The hinges required for connecting the door with door frame shall be heavy duty steel butt hinges conforming to IS: 1341 (latest).

The size and number of hinges required for each door shall be decided as per the overall weight of the door for smooth and trouble free operation under service conditions. The minimum size of the hinges shall be not less than 150 mm.

6.08.00 **Inspection / Maintenance Doors**

- 6.08.01 Two numbers steel leak proof doors (lined internally with borosilicate blocks) of





size 750 x 1000 mm and 750 x 600 mm shall be provided diametrically opposite in each of the flues at each of those levels where internal platforms are provided.

6.08.02 Proper sealing arrangement shall be provided in the doors to ensure leak tightness.

6.09.00 **Hatches**

6.09.01 Hatches shall be provided as required for erection and maintenance. Suitable covers along with proper locking arrangement may be provided, if required, for safety of personnel.

6.10.00 **Elevator & Staircase**

Elevator and staircase within windshield (having two steel flues) shall be provided.

The travel of the lift shall be up to the last platform below the roof. Access to roof from the top most internal platform shall be provided through Galvanized MS Cage Ladder and access hatch with appropriate cover openable from inside the windshield.

Staircase with handrails for chimney will be supported from top of chimney raft & from all internal platforms and not with chimney shell. The staircase will serve all the intermediate levels. Staircase will be constructed in Structural steel. The stair will stop at last internal platform. The staircase in no case will be inclined more than 35° angle with horizontal plane. Width of staircase shall be 1200mm. The riser will be 175 mm and tread of minimum 250 mm The MS handrails shall conform to IS 1161. The staircase with handrails shall be applied three coats of high build heat resistant Epoxy paint over one coat of epoxy primer(refer cl 6.11.00).

6.11.00 **Painting**

The entire inside surface of the chimney shell, horizontal surface of the shell at top, underside of roof slab, top exposed surface of external platforms etc. shall be painted with acid & heat resistant black bituminous paint conforming to IS:158 (not less than four coats including one prime coat). Total dry film thickness (DFT) shall not be less than 150 micron.

Entire external surface of the windshield shall be painted in alternate band of signal red and white colour starting with signal red colour at the top and in line with aviation requirements. out of which top 50m shall be painted with acid and heat resistant polyurethane paint and rest of the outside surface shall be painted with synthetic enamel paint conforming to IS:5410 in alternate bands of red and white colour. Total DFT shall not be less than 150 micron (three coats over one coat of primer). Each coloured band shall be approximately 30m wide.

External painting shall have acid and heat resisting properties conforming to IS-



158. Total dry film thickness (DFT) shall not be less than 150 microns. The top of shell at the roof level shall be painted with three coats of approved paint over a thin coat of the same paint. The overall DFT shall be at least 230 microns.

All steel surfaces (inner & outer) shall be painted with 3 coats of high build heat resistant epoxy paint over one coat of epoxy primer (total DFT of 250 to 290 microns). Special steel surfaces (such as Corten Steel, Stainless Steel, Hot insulated surfaces etc.) shall not be painted.

Surface preparation and paint application shall be in accordance with manufacturer's recommendation.

6.12.00

Sampling & Test Ports for Emission Monitoring

Analyzers for Continuous Emission Monitoring System (CEMS) will be mounted on the chimney as per latest CPCB guidelines. Following tapping points for sampling and test ports will be provided at different elevations of the chimney as per CPCB norms. CEMS analyzers will be procured in a separate FGD system package.

Flue gas sampling ports for on line Emission monitoring instruments & Test Ports for local sampling & testing shall be provided at access platform level.

One (1) nozzle shall be provided for mounting of SO_x, NO_x, CO, CO₂, and Moisture analyzer (Combined analyzer).

One (1) nozzle shall be provided for mounting of O₂ analyzer.

One (1) nozzle shall be provided for Mercury analyzer.

Two (2) nozzles in diametrically opposite position shall be provided for mounting of dust density / Opacity analyzer.

Two (2) nos tappings 180 degree apart and making 45 degree angle with vertical axis shall be provided for ultrasonic type gas flow measurement..

Temperature Test pockets with a stub of size M33X2 shall be provided for installing thermowell for flue gas temperature measurement & correction for opacity measurement.

In addition to the above sampling ports for instrumentation purpose there shall be four gas sampling ports on the stack at 90 degree apart with flanged ends for manual sampling & testing.

one nozzle shall be provided made of 200 NB Duplex stainless steel pipe and projected approximately 200 mm outside the steel flue wall with an upward inclination of 5 Degree with the horizontal plane of flue can for flue gas pressure measurement at location as per the C&I requirement.

Access plat forms shall be provided at all the sampling points or ports and thermo well installation points around the flue can to carry out maintenance works. The working plat forms shall be provided 1.25 meter below the sampling points or ports and thermo well installation points.

Contractor shall furnish the arrangement drawings for the sampling and test points for owner's approval during engineering.

6.13.00 **Acid Proof / Chemical Resistant Protection to Roof**

The chimney roof slab shall be of RCC supported on a grillage of structural steel beams. The roof will be sloped outwards for drainage of water. Acid proof / chemical resistant tiles bedded on acid proof / chemical resistant mortar shall be provided for the protection of the roof slab. The intervening space between tiles shall also be filled up by acid proof / chemical resistant grouts. The mortar shall be acid proof mortar – Potassium Silicate type resistant to Sulphuric Acid as per IS: 4832 Part I & IS: 4441. The mortar shall be used immediately after mixing.

Tiles shall be made of clay, feldspar or quartz and vitrified at high temperature in ceramic kiln. These shall be unglazed, free from deleterious material and shall conform to IS: 4457. Iron oxide in the raw material shall not exceed 2%. These shall show a fine-grained homogeneous fracture when broken and shall be sound, true to shape, flat and free from flaws and other manufacturing defects. Dimension of the tiles shall be 198.5 x 198.5 x 35 mm minimum. Depth of groove on the underside shall not be more than 3 mm. Compressive and tensile strength of tiles shall not be less than 70 N/sq.mm and 3.5 N/sq.mm respectively.

6.14.00 **Roof Drainage**

Rain water outlets and down comers to be provided for roof drainage shall be heavy DI pipes and fittings conforming to IS: 8329 .

6.15.00 **Transition Ducting**

The battery limit of incoming flue gas duct and center line elevation of duct shall be determined as per layout given by FGD package Contractor. Terminal point for incoming flue gas Duct shall be 1.0 (one)m away from the Chimney shell at about 45m height (to be confirmed at the detail engineering stage after getting confirmation from FGD package vendor). Flue gas Expansion joint and Transition piece for Rectangular duct to Circular flue shall be provided by Chimney package Bidder. The change in direction from horizontal to vertical for transition duct shall follow smooth turning. Apart from construction of chimney windshield and internal platforms, supply and erection of flue cans from the downstream of the terminal point up to final discharge point in atmosphere shall be under the scope of Chimney package. The duct work profile and the guide vanes as required to be done by Bidder shall be so configured and sized to achieve the desired flue gas flow characteristics and to minimize flue gas pressure losses. The duct work and its supporting structures if any shall be



designed for the most onerous of the possible combinations of gravity loading, seismic loading, flue gas pressure loading and thermal loading. Like in the case of steel liners, the minimum thickness of duct plates shall not be less than 10 mm in any case from structural condition and corrosion allowance point of view. Clean-out door shall be provided below the each flue for the removal of ash.

The design, detailing, fabrication, erection etc. of the platform, structure supporting the transitional duct within the RCC windshield shall be under the scope of Chimney package bidder.

6.16.00 Flue Openings and Duct Work

The concrete shell at flue duct entry shall be adequately protected against high temperature by cast able refractory lining and the gap between the shell and duct shall be properly sealed off by any other suitable seal.

The openings in the windshield shall be sufficiently reinforced to withstand design loads. Similarly the openings in steel flues shall be properly reinforced for receiving the flue ducts.

The R.C.C. shell shall provide support for duct work from the expansion joint to the chimney liner.

Exposed ductwork shall be insulated and lagged to protect equipment & prevent injury to personnel. The insulation and wire mesh shall be secured to the lagging by means of pins or prongs welded to the exterior sheet and spaced on intervals not exceeding 450 mm in both the directions. The insulation shall be impaled over the pins or prongs, wire mesh applied over the insulation and the insulation and mesh shall be held in place with speed clips.

6.17.00 Lightning-Protection System

The air terminals shall be fabricated from a solid rod made of Alloy C276. Conductors, attachments, and fasteners located within the top 25 ft (8 m) of the stack should be lead-covered.

6.18.00 Electrical Conduit

All rigid steel conduits and accessories within the top 30 m on the exterior of the stack should be installed with a bonded PVC jacket. Conduit located within the top 100 ft 30 m on the exterior of the stack should be supported with Type 316 stainless-steel unistruts, clamps, and fasteners. Because of corrosion resistance and weather-tight requirements, all electrical boxes located within this area should be NEMA 4X.

7.00.00 Wind Tunnel Test for Chimney

Wind Tunnel Test for the RCC Stack is to be carried out. A model test has to be performed in a wind tunnel to predict aerodynamic behaviour of the prototype





without strakes. The technical details, location and other features of the Stack to be tested are to be provided along with necessary drawing showing stack outline, General arrangement Plan, section, elevation and mass details of the stack and other details as required for the test.

The tests shall be carried out on the model of the proposed Stack considering without flue and with flue conditions. The model test shall be carried out without strakes. Interference effects due to presence of adjoining structures to be studied along with other required parameters including detailed aerodynamic behaviors.



**Tender Specification
for
Chimney**

**NLC TamilNadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: B

SUB SECTION: II

**TECHNICAL SPECIFICATION FOR CONSTRUCTION
OF REINFORCED CONCRETE CHIMNEY**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part B; Sub Section: II
Technical Specification for Construction
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CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	CONSTRUCTION BY SLIP-FORM METHOD	1
2.00.00	GUIDELINES FOR SLIP FORM METHOD	2
3.00.00	CONCRETE	7
4.00.00	REINFORCEMENT	12
5.00.00	CHIMNEY STEEL AND METAL WORK	12
6.00.00	INSULATIONS AND PROTECTIVE TREATMENTS	14



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**Volume: II-B
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Technical Specification for Construction
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**VOLUME: II-B
SECTION: I**

PART: B

SUB SECTION: II

**TECHNICAL SPECIFICATION FOR CONSTRUCTION
OF REINFORCED CONCRETE CHIMNEY**

1.00.00 CONSTRUCTION BY SLIP-FORM METHOD

Chimney construction shall be carried out using slip form shuttering technique. Type of Slip-form proposed shall be indicated in the offer with sketches, drawings and description as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour shall be indicated. The chosen scheme shall be of a past proven design. Performance record of the scheme shall be submitted with the offer for review and verification by the owner / consultant.

The Bidder shall furnish a brief but comprehensive description indicating the plan, programme and method of work proposed, for the approval of Owner at the time of submitting Bid. This description shall include the following items:

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





- xii) Time of completion.

Also refer to Subsection-I of Vol-II B-Section-I, Part-B.

2.00.00 GUIDELINES FOR SLIP FORM METHOD

Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which shall be kept in view by intending Bidder, while quoting for Slip-form method of construction:

1. Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps may be adopted:
 - a) Shutter plates shall be smooth and shall be thoroughly cleaned. Before fixing them in position all the surfaces that will be coming in contact with concrete to have a coat of epoxy paint.
 - b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.
 - c) Mix design shall be such that it shall be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.
 - d) Mix design also shall be such that a slump of 50 mm is achieved at the point where concrete is placed under an ambient temperature of around 40 °C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizers of approved manufacture may be added in mix to meet this requirement. These admixtures shall be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40°C.
2. Care must be taken to prevent twist, which, predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person shall exclusively be assigned for this purpose.





3. Every endeavor shall be made to prevent any tilt in the shutter assembly. To achieve this, following steps need to be taken:
 - a) Performance of jacks shall be closely monitored and any defective one shall be immediately replaced. Difference in levels of opposite jacks at any instant of time shall not exceed 5 mm.
 - b) Loading on Slip-form truss/yokes shall be evenly distributed as far as practicable.
 - c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.
4. For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.
5. In designing the mix following aspects should be borne in mind:
 - a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm. per gram.
 - b) Coarse and fine aggregates should be well graded and rounded. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 20 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.
 - c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should be controlled perfectly as per mix design.
 - d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds should be between 0.1 to 0.2 Newton/ Sq.mm.
6. Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slip form operation. Concrete shall be laid in layers and vibrated properly to have sound concrete without any honey combs.
7. It is preferable to have membrane-curing compounds sprayed on fresh

surfaces emerging out of shutter panels for ensuring proper curing at great heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilization of the system.

8. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

It is desirable that jacking system, based on which the entire slip form system works, should consist of jacks 3 Tonne / 6 Tonne capacity and a hydraulic pump with necessary pipe connections.

Spacing of yoke legs should preferably be kept within 2 meters to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

9. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.
10. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.
11. For effective utility of this technique following areas need careful attentions at the very conceptual stage:
- a) Detailed quality assurance programme.
 - b) Advance Planning and preparations.
 - c) Arrangement for on-site supervision and adequate access facilities.
12. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be



approved by Consultant before starting the actual work.

13. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slip form system.

14. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jack rods etc.
15. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.

For movement of personnel supervising the work a separate hoist must be arranged for.

16. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.
17. Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.
18. Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.
19. A small laboratory shall be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube-testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

20. In case of interruption in the course of slipping, the formwork shall be brought up above the already poured concrete and following measures shall be taken:

Provision of a key and additional reinforcement at the junction of new and old concrete.





- a) Slip form system shall be lowered to have a minimum overlap of 100 mm or so over previously cast concrete. Chipping of old concrete surface to remove laitance and washed with water jet and cleaned with compressed air and thereafter pouring a layer of neat cement grout.
 - b) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Consultant.
 - c) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.
21. It is preferable to suspend the construction work under high wind condition.
22. It is of utmost importance that for effective implementation of this system a Consultant fully conversant with Slip form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid-level supervisory staff, skilled workers and operators.
23. Operation of slip form method of construction is a continuous one and it demands continuous inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.
24. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities shall be carried out under the guidance of a qualified and trained safety Consultant.

Safety measures as listed below, but not limited to only these shall be adhered to:

- a) Safety helmets and belts to be provided to all supervising staff and workers.
- b) Safety nets to be provided below both inside and outside platforms as instructed by the safety Consultant.
- c) Hand railing and toe guard to be provided around all openings and platforms.
- d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.
- e) Passenger hoist must have multiple ropes.





- f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slip form method of construction.
- g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

All The safety appliances including wire ropes shall be got inspected periodically by the approved statutory agencies and the inspected reports shall be submitted to the owner.

25. Permissible construction tolerances shall be limited to the following:

Variation in wall thickness	: (-) 5 mm, (+) 25 mm
Variation from Design Diameter	: (+) 25 mm or (+) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (+) 75 mm.
Out of Plumb in General	: 1 in 1000 of height subject to a maximum of 200 mm.

Also refer to Subsection-I of Vol-II B-Section-I, Part-B.

3.00.00 CONCRETE

3.01.00 Trial Mix, Grades of Concrete

At least three weeks before commencing any concreting in the work the Bidder shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Bidder. The Bidder's design mix shall fall within limits of the following tables :-

- i) Strength requirements of concrete : Table-2 of IS:456.
- ii) Concrete Mix Proportion : Table-9 of IS:456.
- iii) Minimum cement content/Cu.m. of finished concrete shall be as per IS-456.(however for all RCC works the minimum cement content shall be 400kg/cum)





- iv) Limit of consistency : Refer Table in Item 3.0.4 of this specification.
- v) Cement/Total Aggregate Ratio : As per the following table.
- vi) Design mix as per IS 10262.

**MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES
OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATES RATIOS**

Workability	Water/ Cement Ratio	Ratio by weight of cement to gravel aggregate		Ratio by weight of cement to crushed stone aggregate	
		20 mm. size	38 mm. size	20 mm. size	38 mm. size
Very Low slump 0-25 mm.	0.4	1:4.8	1:5.3	1:4.5	1:5
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4
	0.5	1:5.5	1:6.7	1:5	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7
	0.7	1:8	1:8.5	1:7.4	1:8
Medium slump 50-100mm.	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5
	0.6	1:6	1:7.3	1:5.2	1:6.2
High slump 100 - 175 mm.	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE -1:

Notwithstanding anything mentioned above, the cement /Total aggregate ratio is not to be increased beyond 1:9 without specific permission of the Engineer.



NOTE - 2:

It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty-eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Consultant. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Consultant.

Also refer to Subsection-I of Vol-II B-Section-I, Part-B.

3.02.00 Batching of concrete

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer-in-charge.

3.03.00 Mixing of Concrete

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer-in-charge, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.04.00 Workability of Concrete

The degree of workability necessary to allow the concrete to be well

consolidated and to be worked into the corners of formwork and around the reinforcement and embedment, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slump in chimney works shall be adopted subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 2.00.00). The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm. with standard concrete		Use for which concrete is suitable
	Min.	Max	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC with congestion due to reinforcement and inserts.

NOTE : The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer-in-charge.

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

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

3.05.00 Placing and Compaction of Concrete

Concreting shall proceed in a manner directed by the Engineer-in-charge, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.



The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height, which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.06.00 Curing of Concrete

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Bidder shall plan and employ proper equipment and sufficient labour considered adequate by the Owner under able supervisor for curing and all cost for this purpose shall be borne by him.

The Bidder may adopt spraying of curing compound as per manufacturer's recommendation.

3.07.00 Construction Joints

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Bidder for forming joints or chipping and



cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Bidder shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.01.08 Ordinary Concrete

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS: 456.

4.00.00 REINFORCEMENT

4.01.00 Bending of Reinforcement

All bars shall be carefully and accurately bent by the Bidder in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS: 2502.

4.02.00 Placing

All reinforcement shall be placed and maintained in the position shown in the drawings. Bidder shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Bidder shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer-in-charge.

4.03.00 Fixing of Reinforcement

18 SWG annealed steel wire of two strands shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

5.00.00 CHIMNEY STEEL AND METAL WORK

5.01.00 General

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.



5.02.00 Fabrication

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:852. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat, the temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length, based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt-holes shall not be formed by a gas-cutting torch.

5.03.00 Assembly

Riveting, bolting and welding shall be carried out as per requirements laid down in IS: 800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking, written in paint.

5.04.00 Painting

If steel and iron members are to be painted as per contract, it shall be done as per requirement laid down in IS: 800. A coat of shop painting shall be applied to all steel and metal work, unless stated otherwise. All steel ladder, platforms, balconies, stairs, hand railing, frames, doors etc. which are specified for painting shall be painted as specified in section I of Part B/volume II B.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature and samples shall be submitted to the Engineer for his approval, before bulk purchase is made.

The metal surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

5.05.00 Galvanizing

wherever galvanizing specified in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS:2629 - Recommended practice for Hot- Dip Galvanising of





Iron and Steel.

Members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

5.06.00 Erection

Erection of structural members and Stainless steel Chimney caps shall be done as per requirement of IS: 800. The Bidder shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Bidder. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Bidder and shall be taken into account in quoting the rate.

5.07.00 Stainless steel Chimney Cap

The stainless steel cap, fitted at the top of the chimney, shall be of thickness not less than 10 mm. This shall preferably be a single cap covering both the concrete shell and the lining, with the segments bolted together securely and properly anchored inside the concrete in such a manner as to form a complete annular unit, allowing for unequal circumferential and vertical expansion and contraction of concrete shell and lining and for deflection of shaft due to wind.

All bolts, nuts, washers, rag bolts and other fasteners as required for fixing stainless steel cap shall be of bronze material. Gaps between segments are to be filled with asbestos mill-board or fibre-glass packing. Cap is to be assembled as sloping outside and to match with the dimensions specified in approve drawings, before despatch to site.

6.00.00 INSULATIONS AND PROTECTIVE TREATMENTS

6.01.00 Borosilicate Lining

As per Vol-II-B Sec-I-Part B-SS-I.





6.02.00 Paint

The outside face of the Chimney shell, unless specified otherwise, shall be painted with alternate bands of signal red and white colour, out of which top 50M shall be painted with acid and heat resistant polyurethane paint and rest of the surface shall be with synthetic enamel paint confirming to IS 5410. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Bidder, at his own cost, shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS: 5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

6.03.00 Lightning Protection System

The lightning protection system to be installed on the chimney by the Bidder shall be strictly as per specifications and shall satisfy the requirements described in Electrical Part of this SPEC in Vol-II B-Section-III.

6.04.00 Aviation Obstruction Lighting System

The Bidder shall supply and install the aviation obstruction Lighting system on the chimney strictly as per specification and shall consist of the items described in Electrical Part of this SPEC in Vol-II B-Section-III.



VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: I

**SPECIFIC DESIGN REQUIREMENTS
[CIVIL]**





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTRODUCTION	1
2.00.00	GEO-TECHNICAL SYSTEM	1
3.00.00	LOADS	2
4.00.00	DESIGN OF REINFORCED CONCRETE STRUCTURE	11
5.00.00	FOUNDATION DESIGN	13
6.00.00	GENERAL REQUIREMENTS	15
7.00.00	ROADS	17
8.00.00	DRAINAGE	18
9.00.00	MISCELLANEOUS DESIGN/ CONSTRUCTION CRITERIA	18





**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: I

SPECIFIC DESIGN REQUIREMENTS [CIVIL]

1.00.00 INTRODUCTION

This section outlines the followings:

- a) A brief description of Soil Characteristics.
- b) Design considerations for Reinforced Concrete Structures.
- c) Design considerations for Foundations.
- d) Roads.

2.00.00 GEO-TECHNICAL SYSTEM

Detail soil investigation, as required, to be carried out for foundation design of various facilities.

Soil characteristics and parameters to be adopted in final design, the successful bidder is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required.

It should be noted that nothing extra whatsoever on account of variation between soil data annexed in this specification and that found by detailed geotechnical investigation to be carried out by bidder shall be payable.

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 (Latest) and on the basis of the soil investigation Report done by the Bidder. The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.

Soil & water samples of the proposed site has high concentration of sulphate (as per soil report) & has also concentration of chloride in the sample & hence adequate measure to take care of this as per IS 456 will be considered.





3.00.00 LOADS

Design, loading, load combinations, Concrete grades, cover to reinforcements etc. for Chimney structure shall be as per SUBSECTION-I of Volume: IIB, SECTION-I PART-B.

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements.

All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

a) Dead Loads

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, Ash storage bins shall be measured at full capacity for this purpose. Hung loads and the contents of tanks and bins shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	Unit weight
Plain cement concrete	: 24.0 kN /cum
Reinforced cement concrete	: 25.0 kN /cum
Structural steel	: 78.5 kN /cum
Brick work	: 19.0 kN /cum
Cement plaster	: 21.0 kN /cum
Floor Finish	: 24.0 kN /cum
Coal	: 12.0 kN /cum
Fly Ash	: 16.0 kN /cum
Bottom Ash	: 16.0 kN /cum

b) Live Loads

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part 2).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary.





Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

Electrical Building

a) Roof:

Inaccessible roof (Flat) : 1.5 kN/Sq.m + hung loads,
if any + 0.5 kN/Sq.m (dust load).

Accessible roof where
equipments are placed : 5 kN/Sq.m + hung loads,
if any + 0.5 kN/Sq.m (dust load).

Accessible roof
Without equipments : 1.5 kN/Sq.m + hung loads,
if any + 0.5 kN/Sq.m (dust load).

Inclined roof : As per IS: 875 (Part 2)

b) Stairs & Platforms : 5.0 kN/Sq.m

c) Corridors : 5.0 kN/Sq.m

d) Removable gratings,
chequered plates,
walkways etc. : 5.0 kN/Sq.m

e) Ground Floor : 10 kN/Sq.m

f) Cable Spreader Floor : 7.5 kN/Sq.m

g) Office Floor : 5 kN/Sq.m

h) Switchgear room : 15 kN/Sq.m

i) All other Floors : 10 kN/Sq.m

iii) Underground Structures/Trenches/pits

Minimum surcharge shall be 20 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification.





Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/Sq.m whichever is greater.

iv) **Covers for Trenches / Channels**

Self-weight of top slab and a uniformly distributed load of 100 kN/Sqm on each panel or one 100 kN central point load, whichever is critical, shall be considered. At road crossings and entrance of the buildings wherever vehicle/crane movement is expected, the covers shall be designed for vehicular movements as per IRC standards

v) **Roads**

Design of roads shall be in accordance with Indian Road Congress standard IRC 15 & IRC-58.

vi) **Road Culverts and its allied structures including Road Crossing of Trenches.**

At all road crossings RCC box culverts along with manholes on both sides shall be used. Such road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class 'AA' loading (wheeled and tracked both) and to be checked for Class 'A' loading as per IRC standards.

Reduction in Live load as per provision of IS: 875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to a uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater. Foundations and fixing arrangements for items of equipment, which generates vibration, shall be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

c) **Equipment Loads**

- i) Loadings (both static and dynamic) of equipment obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings shall be estimated from similar jobs or catalog data.
- ii) All equipment, tank and piping design loadings shall include Hydraulic Testing loads.
- iii) Air and gas duct loadings shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other



loads as applicable.

- iv) Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads.

Unless otherwise specified, the vertical and horizontal loadings shall conform to the applicable sections of the IS specifications.

- v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.
- vi) All structural components shall be designed to accommodate anticipated concentrated loads which shall or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

- vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

d) Wind Loading

Wind loading shall be in accordance with Indian Standard Code IS:875 (Part 3) (Latest Revision) for a basic wind speed of 39 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k_1) shall be considered as 1.06 for all structures.

Notwithstanding the design wind forces calculated based on above parameters, the structures shall not be designed with a wind pressure less than 1.5 KN/sqm

e) Seismic Loading

The lateral forces shall be established in accordance with the recommendations of IS: 1893 (Latest Revision). The site falls in Zone-II as identified in the map in IS: 1893 and hence seismic forces would be considered accordingly for the structures and buildings. Importance factor shall be taken as per latest versions of IS: 1893 parts.

f) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose shall be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Minimum ambient temperature = 20.8°C

Maximum ambient temperature = 36.5°C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) NOT USED

h) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be considered as 2.0 t/sq.m in general unless mentioned otherwise.

i) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter. For frame analysis, the lateral crane surge shall be applied on one side of the frame at a time and in either direction.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS: 875 / IS: 807 (Latest Revision). The minimum impact factor to be used in design shall be as follows:

Crane loads

- a) For vertical force, an impact factor of 25% of the maximum crane wheel load for crane girder 10% for column and foundation.
- b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail.
- c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

- a) Impact factor of 10% of lifted load of hoist for monorail and support design
- b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

j) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing as far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

k) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

l) Thrust Load

Thrust blocks shall be designed against the thrust load from pipe lines considering the test pressure in the pipe lines and as per the relevant IS Code with adequate factor of safety.

3.01.00

Stability of Structures

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.20 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any

overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

- a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
- b) Factor of safety against sliding shall be 1.5 minimum.
- c) Factor of safety against uplift due to hydrostatic forces shall be 1.20 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

3.02.00 Load Combinations

Buildings and structures shall be designed to resist the load stated in the previous section acting in the following combinations.

While designing consideration shall be given to the following load combinations:

- i) $DL + LL$
- ii) $DL + LL + PL + Equip \pm TL$
- iii) $DL + LL + PL + Equip + Cb + CtLA \pm CS \pm TL$
- iv) $DL + LL + PL + Equip + Cb + CtLB \pm CS \pm TL$
- v) $0.9DL \pm EL \text{ (for DL only)} \pm TL$
- vi) $0.9DL \pm WL1 \pm TL$
- vii) $0.9DL \pm WL2 \pm TL$



- viii) $DL + *LL + PL + Equip + Cb + Ct \pm EL \pm TL$
(* Appropriate portion of LL which is considered for working out EL shall only be taken)
- ix) $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1+WL1) \pm TL$
- x) $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1+WL2) \pm TL$

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe Load

Equip = Equipment loads

Cb = CraneBridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be





considered along with external pressures as per IS:875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for the combinations as stated above to assess worst effect on whole structure as well as its components.

Seismic Load shall be considered in all three directions for analysis and design of Structures.

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses shall be permitted.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS: 456.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 (Latest Revision) against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

3.03.00

Design Concepts

Wind and seismic forces shall not be considered to act simultaneously.

‘Lifted Load’ of crane shall not be considered during seismic condition.

For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level.

If R.C.C. floors and roofs except those cast over metal decking are assumed to act as diaphragm transmitting lateral loads to braced bays then main beams/girders shall be provided with shear connectors. However, whenever large/more number of cutouts is 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. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening /chequered plate / grating on other side.





For calculation of seismic load, equipment load shall be considered as Dead Load.

Whenever any structure under this contract shall carry or receive additional load from the work of any other contract, the structures under this contract shall be provided with sufficient margin to carry the above load, details of which shall be finalized during detail engineering.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES BY BIDDER

- a) Reinforced Concrete Structures shall be designed in accordance with the requirements of IS-456 (Latest Revision) & IS-875 (Latest Revision) or as specified in this specification for all possible combination of loads, e.g. dead load, live load, crane loads, wind or seismic loads, soil loads and surcharge loads, etc. The grade of concrete for RCC shall be M-35 for all structures.
- b) Corrosion inhibitors of approved make will be used in Concrete for all RCC work (excepting for storm water drains) as per standards and manufacturers specification.
- c) Minimum cement content for RCC for aggressive environment like Tuticorin shall not be less than 400 kg/m³ for M-35 and above grade.
- d) If concentration of Sulphate (measured as SO₃) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement may be used for all substructures.

The following grades of concrete as per IS-456 shall generally be used.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Sl. No.	Class	Grade of conc.	Min. cement content Kg/Cum	Max. free water cement ratio
1.	i) Plain cement concrete used for and fill between two foundations one above other at different levels ii) Lean concrete below all foundations, plinth beams, drains, pits, etc.	M15 M10	240 -	0.6 -
2.	i) Plinth protection.	M35	400	0.55
	ii) Paving, Grade slab, RCC drains and trenches	M35	400	0.55
3.	i) Reinforced concrete for super structure and foundation ii) RCC roads	M35 M35	400 400	0.45 0.5
4.	Pre-cast concrete	M35	400	0.5
5.	Piles	M35	400	0.5

- e) Reinforcing bars shall be TMT bars of minimum grade Fe 500 CRS conforming to IS-1786 (Latest Revision) and Mild Steel bars conforming to IS: 432 (Grade I) (Latest Revision) of vendor approved by Owner. Fe500D/Fe550 CRS may also be used but the design is limited to Fe500only.

Test certificate for reinforcement steel will be obtained from recognized agency, before using . If the steel is purchased by the contractor, purchaser may desire to check the testing of the same & the contractor will arrange it in approved laboratory at his own cost”.

- f) Higher grade of Ordinary Portland cement namely Grade 43 conforming to IS: 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) may be used wherever necessary and directed by Owner.

Grade of cement shall be OPC and for underground structures, it shall be minimum 5% -8% C3A content.

- g) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456 (Latest Revision).
- h) NOT USED.
- i) Grouting material:





Grouting shall be done with Conbextra GP-2 or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips. Grouting thickness shall be 50mm minimum.

- j) For reinforcement detailing IS: 5525 (Latest Revision) and SP:34 shall be followed.
- k) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

5.00.00 FOUNDATION DESIGN

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 (Latest Revision) and on the basis of the soil investigation Report done by the Bidder.

Foundation shall be checked for safety against overturning, sliding and uplift. High ground water level up to final graded ground level shall be considered to take into account buoyancy effect.

Pile foundation, shall be designed in accordance with IS: 2911(Part-I / Sec-I, II and III) (Latest Revision).

The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.

5.01.00 Foundations

Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns shall have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Common foundation should be provided for columns both side of the expansion joint and shall be designed for loading on both columns.

Foundations for Buildings and structures shall be designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for those structures. The foundation sections shall be sized and reinforced adequately for moments and shear stresses.

5.02.00 NOT USED

5.03.00 Pile Foundations

For Pile Foundations, following shall be adhered to:





- a) The pile foundation shall be of RCC, Cast-in-situ bored, pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.
- b) The minimum diameter of pile shall be 450mm for cast-in-situ piles. The uplift and lateral load capacity shall be established by field test.
- c) Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.
- d) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter like (SPT & SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc.) for Owner's approval.
- e) The piling work shall be carried out in accordance with IS: 2911 (Relevant part) (Latest Revision) and accepted construction methodology. The construction methodology shall be submitted by the Bidder for Owner's approval.
- f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical	}	As specified in IS 2911 for each mode.
Lateral		
Uplift		

The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per IS: 2911 (relevant part) (Latest Revision).

- g) Routine pile load tests shall be performed for each diameter/allowable capacity of pile.

The routine tests on piles shall be conducted up to test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4) (Latest Revision).

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 Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required,





without additional cost to the Owner.

- h) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4) (Latest Revision). Bidder shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.
- i) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

5.04.00

Other Requirements

- i) In case of high ground water table, for excavations comprehensive dewatering arrangement shall be required. Scheme for dewatering and design with all computations and back-up data of dewatering and sheet piling shall be submitted for Owner's information.
- ii) The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches/channels.
- iii) Excavation for open foundations (for floors, roads, drains, trenches, etc.) shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC of Grade M10. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.
- iv) Backfilling, around foundations shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.
- v) Excess/surplus excavated material and debris shall be disposed of by the Bidder as per the instructions of the Owner up to a lead of about 10 km.
- vi) CBR tests for rigid / concrete pavement design shall be carried out by Bidder after earth filling has been completed, if applicable.

6.00.00

GENERAL REQUIREMENTS

6.01.00

Minimum Thickness of Structural Elements

The following minimum thickness shall be followed:

Pile caps

900 mm





Suspended floor / slab / walkways / canopy slabs, etc.	150 mm
Ground floor slab/Grade slab (non-suspended)	200 mm
Water Retaining slabs / walls	200 mm
Walls of Cable / pipe trenches / underground pits / Lauder walls and base slab	150 mm
Drain walls and base slab	125mm
All footings (including raft foundations)	300 mm
Parapets	125 mm
Sunshades at edge	75 mm
Pre-cast trench cover slabs / floor slabs / louvers	100 mm
Paving	200 mm
Basement walls and base slab	250 mm

The above are minimum requirement only unless otherwise mentioned elsewhere in the specification.

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per Fig 1 or Table 16a of IS 456 (Latest Revision) or specified above, whichever is higher.

6.02.00 Minimum Heights for Pedestals/Encasements of Steel Columns

Pedestals to Steel Columns for building structures:

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

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

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

Pedestals to Steel Columns for Equipment structure:

- a) Equipment in open area : as required (300mm min)
- b) Equipment in covered area : as required (150 mm min)





- c) Structures and equipment : as per vendor's data
supplied by vendor subject to minimum as
specified above

6.03.00 Ground floor slab-on-grade

Ground floor slab-on-grade shall be minimum M-35 grade RCC construction laid over minimum 75mm thick lean concrete of M10. Minimum consolidated 230mm thick graded stone or laterite (63mm down size) soling with interstices filled with sand/gravel and compacted mechanically, shall be provided as sub-base below lean concrete. The sub-base shall be laid over rammed and well-compacted earth fill.

The ground floor slab shall be of minimum 200 mm thick with double layer reinforcement of 8mm (minimum) dia at the rate of 200 (maximum) c/c both ways.

6.04.00 Stairs, Platforms, Handrails

All internal stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 8mm thick chequered plate construction. All outdoor stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 40mm thick GI grating (40x6 mm flats).

All handrails made of MS hand railings with 40 mm NB (medium) main posts and 32 mm NB (medium) as horizontal rails as per IS:1161(Latest Revision) with toe guard of 150x6mm shall be provided. Painting shall be as per sec I /SS I/part B/vol II B.

7.00.00 ROADS

Geometric design of road shall be done in accordance with Indian Road Congress Standard. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test, shall be carried out as per the procedure outlined in IS-2720 (Part-XVI) (Latest Revision). CBR test shall be carried out in remoulded soil samples under soaked condition.

All roads shall have hard shoulder on either side of carriageway. Shoulders shall have sufficient load bearing capacity to support loaded trucks. A flatter slope of 1 in 30 shall be provided on shoulders.

RCC box culverts, as suitable, shall be provided at road crossings for drainage, LP pipes, Ash pipes, cable trenches, waterline pipes, etc. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

At all road crossings RCC box culverts along with manholes on both sides shall be used. Such road culverts and its allied structures including R.C.C.





Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

All roads with shoulder and drains shall match with the existing connecting roads, shoulder and drains.

8.00.00 DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 125 mm or as per design considerations whichever is higher. Drains shall have minimum 600mm base-width. RCC culverts shall be provided for road crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec.

9.00.00 MISCELLANEOUS DESIGN / CONSTRUCTION CRITERIA

- 1) All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab. The grade beam shall be partially above FGL and partially below FGL. Minimum embedment of the grade beam below grade level shall be 300 mm.
- 2) The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.
- 3) For exposed areas, the columns shall have a minimum encasing of 300 mm above paved level.
- 4) Ramps for building entrance shall be cast in situ RCC slab and the slope of ramps shall not be more than 1 (vertical) to 8 (horizontal).
- 5) Minimum 75 mm thick lean concrete M-10 shall be provided below all underground structure, trenches etc., to provide a base for construction.
- 6) The building shall have RCC framed super structure. All walls shall be non-load bearing infilled panel walls.
- 7) Duct banks consisting of PVC/GI conduits for cables shall be provided with reinforced concrete encasing of M35 grade. The minimum depth of top of duct bank from grade level shall be 500mm.





- 8) Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches, manholes supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.
- 9) Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M-35 grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. The minimum drainage slope along line shall be 1 in 1000.
- 10) to 13) NOT USED.
- 14) Anti-termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, switchyard area etc., as per IS-6313 (Latest Revision) and other relevant standards.
- 15) & 16) NOT USED.
- 17) All RCC walls and slabs shall have two layers of reinforcement for section having thickness 150 mm and above.
- 18) All gratings wherever specified, shall be made of 40x6 thick GI flat unless noted elsewhere in the specification. Stairs treads made of grating shall be provided with non-skid abrasive nosing.
- 19) Unless stated specifically elsewhere in this specification, the clear height of roof/beam from finished floor shall not be less than 4.5 M for plant building.
- 20) Unless stated elsewhere specifically in this specification, the finished floor level of the building shall be at least 500 MM above the finished grade level.
- 21) NOT USED
- 22) Sealing of joints shall be done by two part polysulphide sealant and shall be from approved manufacturer conforming to IS: 12118 (Latest Revision). Material shall consist of polysulphide polymer and a curing agent. If any similar design criteria mentioned elsewhere in this specification contradict the above, the stringent of the criteria shall be adopted for design.
- 23) Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed.





VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: II

**SPECIFIC DESIGN REQUIREMENT
[STRUCTURAL]**





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	STRUCTURAL STEEL DESIGN	1
2.00.00	LOADS	4
3.00.00	LOAD COMBINATIONS	4
4.00.00	OTHER SPECIFIC REQUIREMENTS	6





**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: II

**SPECIFIC DESIGN REQUIREMENT
[STRUCTURAL]**

1.00.00 STRUCTURAL STEEL DESIGN

- a) Structural steel design shall be carried out as per the National Building Code with specific consultation to IS-800 (Latest Revision) unless noted otherwise.
- b) Lateral forces along the length of the building shall be resisted by bracings in horizontal and vertical frames. The transverse lateral load shall be resisted by stiff jointed frame action. Additional bracing or moment connection shall be used to assure stability of the structures.
- c) Structural steel will conform to Grade E350 / E250 of quality (A/BR/B0), semi killed / killed as per IS: 2062 (latest) for rolled steel members or plates. All structural steel plates and sections shall be procured from any make approved by Owner.

For Crane Girder Steel will confirm to Grade E350 / E250 of quality C (Killed).

- d) Shop connections shall be all welded and field connections shall generally be bolted unless specified otherwise. Field bolts, wherever provided, shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS-1367 (Latest Revision) for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. shall be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS-1363 (Latest Revision) unless specified otherwise.
- e) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice (Latest Revision) for use of metal arc welding for general construction in mild steel and IS-9595 (Latest Revision) - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members shall be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns shall be full penetration.





All butt welds shall be radiographically or ultrasonically tested as per relevant IS codes and standard practice.

- f) Galvanizing of steel structures (wherever specified) shall be done after all fabrication work is completed. Zinc coating over galvanized surface of structural members and threaded fasteners shall not be less than 610 gm/sqm and 375 gm/sq. m. of surface area respectively. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS-1573 (Latest Revision). All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633 (Latest Revision). All galvanizing work shall be done at shop.
- g) Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed (refer vol II B/part B /sec I/SS I).
- h) All welding electrodes shall be of Low Hydrogen type conforming to IS: 814 (Latest Revision). All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. Or any other equivalent manufacturer accepted by Owner.

Alternatively, flux coated arc welding (FCAW) conforming to AWS- can be used.

- i) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63mm, it shall be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and shall be followed as per approved welding procedure.
- j) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows:

Steel

Ultrasonic Test : Plates above 25mm thick shall be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test : 5% of the total length, Dye penetration shall be carried out to the root run.

Butt weld :





Dye Penetration Test : 10% of the total length, Dye penetration shall be carried out to the root run after back gouging

Radiographic Test : Generally splicing should not be provided in tension flange of Bunker Girders and crane girders. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300mm length shall be spot radiographed. When radiograph is not possible ultrasonic test shall be carried out after grinding the surface.

Ultrasonic Test : 10% of all other Butt welds except crane girder and bunker girder shall be subject to spot radiographic test and the entire balance butt weld for ultrasonic test.

k) **Connections**

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section shall be as follows:

- Full shear capacity for box section.
- 80% of full shear capacity or actual shear (if indicated in Sellers drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.
- All welds will be continuous. The minimum size of fillet weld shall be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections shall be provided during erection:





Welded Connection

Connection of secondary beam to main beam
Connection of bracing to column
Connection of bracing to longitudinal tie beam
Connection of longitudinal tie beam to column
Connection of spandrel beam to column
Connection of other secondary structures

HSFG Connection (Grade 8.8 bolts)

Splicing of column/transverse frame beam/ longitudinal tie beam
Connection of frame beam to column
Connection of Crane Girder to column
Connection between crane girders
Other major connections

Bearing Type Connection (HT bolts Grade 8.8)

All removable type connections

M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc.

2.00.00 LOADS

Design, loading, load combinations, Concrete grades, cover to reinforcements etc. for Chimney structure shall be as per SUBSECTION-I of Volume: IIB, SECTION-I-PART-B.

Loads as defined under Clause 3.00.00 of Sub Section-I (Vol-IIB, Section-I, Part-C) shall be applicable for structures under this package other than Chimney.

3.00.00 LOAD COMBINATIONS

While designing consideration shall be given to the following load combinations:

- i) $DL + LL$
- ii) $DL + LL + PL + Equip \pm TL$
- iii) $DL + LL + PL + Equip + Cb + CtLA \pm CS \pm TL$
- iv) $DL + LL + PL + Equip + Cb + CtLB \pm CS \pm TL$
- v) $0.9DL \pm EL \text{ (for DL only)} \pm TL$





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- vi) $0.9DL \pm WL1 \pm TL$
- vii) $0.9DL \pm WL2 \pm TL$
- viii) $(DL + *LL + PL + Equip + Cb + Ct \pm EL \pm TL)$
(* Appropriate portion of LL which is considered for working out EL shall only be taken)
- ix) $[DL+LL+ PL + Equip + Cb + CtL1 \pm (CS1+WL1) \pm TL]$
- x) $[DL+LL+ PL + Equip + Cb + CtL1 \pm (CS1+WL2) \pm TL]$

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Limit state method to be followed for design of steel structures as per latest version of IS 800. Applicable load factors to be used for Design of Steel Structures by Limit State Method of strength & serviceability as per IS 800 (Latest).





Appropriate impact factor shall be considered as per IS: 875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS: 875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination numbers (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components. Analysis shall be done in all three directions X, Y and Z.

In absence of any suitable provision for design loads, any other recognized code of practice may be followed subject to prior approval of the purchaser.

Seismic Load shall be considered in all three directions for analysis and design of Structures.

4.00.00 OTHER SPECIFIC REQUIREMENTS

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

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

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However wherever large cut outs (area more than 1.0 sq. m.) are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support in the form of shear connector and horizontal bracing shall be provided as required.

Chequered plates shall conform to IS: 3502 (Latest Revision).

All indoor gratings shall be electro-forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm x 6mm for indoor installation and outdoor installation. The opening size shall not be more than 30mm x 100mm. All gratings shall be hot dip galvanized @ 610 gm/sq.m.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

Permissible Deflections





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

Vertical Deflection

- a) For beams supporting dynamic equipment : Span / 500
- b) For beams supporting floors / masonry : Span / 325
- c) For beams supporting pipes (pipe racks) : Span / 400
- d) For roofing and cladding components : Span / 250
- e) For gratings and chequered plates : Span / 200 subject to a maximum of 6 mm

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

- a) For manually operated cranes & monorails : Span / 500
- b) For electric overhead cranes
 - i) Up to 50 t capacity : Span / 750
 - ii) Over 50 t capacity : Span / 1000

Horizontal deflections

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

- a) Single storey building (without crane load) : Height / 300
- b) Multistoried building (without crane load) : Height / 500
- c) Pipe rack columns : Height / 200
- d) Open Structures : Height / 200
- e) Crane gantry girder due to surge : Span / 2000 limited to maximum of 15 mm
- f) Building main columns at crane rail : Height / 2500 limited to





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

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

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

Expansion joints

Longitudinal and transverse expansion joints shall be provided in buildings and structures in accordance with IS: 800 (Latest).

Miscellaneous Criteria

DI gutters and DI down-pipes with gutter outlets having grating cover shall be provided to carry rain water from roofs of buildings to the drainage system at ground level. All gutters shall be designed as walkable (with provisions of handrails) with 600 mm sole width.

Edges of floors, gangways, stairs and landings shall be provided with safety hand railings. All hand railings shall be of tubular hand railings with vertical post, top rail and mid rail made up with tubes.

Connection by permanent bolts to structural elements subject to vibration shall be provided with lock nuts.

Chequered plates, shall not be considered as structural members for transferring horizontal loads.

Design drawings shall contain Section-wise Bill of Quantity etc .Necessary number of prints of drawings and documents; as per contract shall be submitted for approval.

The slopes of bracings, lacings for columns, diagonal members of trusses, bridges, girders etc shall be kept preferably in the range of 35 to 50 degrees.

Structural schematic general arrangement with plans at various levels, elevations along each row and axes, sections, considered loads and load diagrams with location etc. and Structural design drawings with BOQ and Table of members containing design forces along with design calculations





shall be submitted for Purchaser's/Consultant's approval. STAAD Pro file along with Editable excel sheets with active formulae to be submitted. However the approval shall be limited to checking of overall dimensions, general stability of system, effective load transfer and deflection limits etc. The approval shall not relieve the contractor of his responsibility of correctness in design, adequacy of connections, accuracy etc.

Shear force at the column base shall be resisted either by shear keys shop-welded to the underside of column base plates or by welding base plate to inserts provided in foundation.

The level of underside of column base shall be so chosen such that the complete anchor table lies below the finished floor level, thus keeping the shop floor free from projections of anchor tables.

Minimum thickness of base plate for columns at ground level shall be 25 mm (at other levels 16 mm) and minimum thickness of washer plate at any level shall be 0.8 times of Base Plate thickness.

All Built-up columns shall be provided with nominal stiffeners to maintain orthogonal & torsional rigidity, at a spacing not exceeding 1500 mm centre to centre

Roof Structures

- a) Roof shall have suitable slope (1:5, i.e. 1 Vertical: 5 Horizontal, unless otherwise specified) to meet technological as well as rainwater drainage requirements.
- b) Roof drainage system shall be designed for maximum precipitation for 5 minutes based on local meteorological data. In the absence of meteorological data, precipitation of 2 mm per minute may be considered for designing drainage system. A factor of safety of 1.3 shall be kept in the design.
- c) Poking holes with cover shall be provided in the down-pipes at suitable intervals as well as at accessible levels, to clean the down-pipes.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: III

**SPECIFIC DESIGN REQUIREMENTS
[ARCHITECTURE]**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: III
Specific Design Requirements
[Architecture]**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO	DESCRIPTION	PAGE NO
1.00.00	SCOPE	1
2.00.00	DESIGN REQUIREMENTS	3
3.00.00	ARCHITECTURAL REQUIREMENTS	3
4.00.00	DESIGN DATA FOR ARCHITECTURAL WORKS	11



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: III
Specific Design Requirements
[Architecture]**



VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: III

**SPECIFIC DESIGN REQUIREMENTS
[ARCHITECTURE]**

1.00.00 SCOPE OF ARCHITECTURAL WORKS INCLUDING SANITARY AND PLUMBING

1.01.00 Scope

The architectural services shall cover finishing work of electrical building, starting from brick work, partition walls, roof protection, finishing of walls, floors and false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement.

The bidder offer shall cover the complete requirements as per the best prevailing practices keeping in view the statutory and functional requirements of plants & facilities and providing enough space & access for operation, use & maintenance and to complete satisfaction of the owner.

2.00.00 DESIGN REQUIREMENTS

2.01.00 Codes and Standards

The latest revision of Indian codes and standards are applicable. Unless otherwise stated the latest editions / revision of all related and applicable Indian codes and standards (including IRCs as applicable) along with addendums / amendments, if any, shall be followed. In case the specific Indian Codes and standards are not available, accepted International Codes / standards shall be used.

- National Building Code-2016
- TAC/LPA norms
- Local Fire regulations

2.02.00 Architectural Concepts

The building shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously





imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

Overall colour scheme of the building shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, and other service elements.

Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipment so that the proper co-ordination with other agencies can be taken up at appropriate time.

2.03.00 Architectural Design

- a) Natural light shall be used to the maximum extent especially in the form of north light/skylight. For adequate light and ventilation, National Building Code recommendation shall be followed. However all windows of the building shall have minimum 1.0m sill height and bottom of lintel height shall be minimum 2.5 m from finished floor level and minimum door height shall be 2.5m.
- b) Entrance canopies, sunshade (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- c) The building shall be architecturally designed to meet the National Building Code.
- d) All architectural drawings shall be prepared under responsibility of an Architect. The Architect should be registered under Council of Architecture (COA).
- e) 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 multidisciplinary engineering activities involving power plant technology and architectural & civil engineering for a smooth control hierarchy and man machine interface.
- f) Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.

- g) Minimum 2.1m high headroom clearance has to be maintained at every part of the building including staircases. Vertical Head room clearance shall be maintained as per industry factories Act.
- h) Where false ceiling is to be provided, provision of human access has to be made to maintain the HVAC, Electrical and other service lines above false ceiling.

2.04.00 Description of Electrical Building

The building shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structure shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of building shall be maintained. This Building can be located either inside or outside the Chimney shell based on the functional and operational requirements of Electrical / C&I

3.00.00 ARCHITECTURAL REQUIREMENTS

3.01.00 Roof Insulation and Ventilation

The roof of building shall be provided under deck insulated as per specification given elsewhere in this document. The roof housing manpower and precious equipment's/instruments and AC rooms exposed to heat environment shall be provided with underdeck insulation with false ceiling.

3.02.00 Roof Waterproofing

Roof water proofing treatment shall be as follows:

After curing of the concrete, the roofs of building shall be provided with 3 layers, first being minimum 1.5mm thick elastomeric membrane waterproofing treatment coating with $\geq 500\%$ elongation confirming to ASTM C836 applied by a spray/brush/roller in two coats, secondly 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating over which screed concrete (of M20 with 12mm blue metal chips) shall be laid and finally the wearing course. 1.5mm thick Elastomeric membrane shall be laid as per manufacturer's specification. Run off gradient shall be given a minimum of 1 in 100. Gradient shall comprise screed concrete M20 using 12.5 mm or below coarse aggregate and waterproofing treatment as per IS:2645, mixed with polypropylene fibres. Over the screed concrete wearing course treatment shall be provided as below:

A wearing course shall consist of pressed clay tiles of size 230x230x18 mm



minimum laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.

3.03.00 Partition Wall

All intermediate walls shall be full brick thick wall in 1:5 cement sand mortar. Half brick thick wall in 1:4 cement : sand mortar with 2 nos. 6 mm dia rod in every fourth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided. . Full glazed partition in powder coated aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area.

3.04.00 Plastering

Exterior & rough side of interior brick wall	20mm thick minimum sand faced plaster with 1:4 cement-sand mortar in two layers.
Interior wall	12 mm thick with 1:4 cement-sand mortar
Ceiling	10 mm thick with 1:3 cement-sand mortar shall be provided to all exposed ceilings.

3.05.00 False Ceiling

Stove-enamelled Aluminium false ceiling, similar or equal to LUXALON with either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Under deck insulation is to be provided in areas of as per HVAC requirement.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183 over the false ceiling panels. Wherever under-deck insulation is required, the insulation shall be as per specification mentioned elsewhere in the specification, and shall be glued to the roof.

3.06.00 Doors

- Factory made hollow metal (steel) flush doors with pressed steel frame shall be provided in general area.
- At main entrance of the building Rolling steel shutter shall be used where frequent use is not envisaged and large openings-9.0 Sqm and above- are required. Rolling shutters shall be electrically operated.
- Special areas like control rooms and other special area shall be



provided with minimum 15 micron pre-coated i.e. colour powder coated aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

- d) Doors shall be provided at appropriate location to prevent dust ingress from outside.
- e) Wooden panel doors with teakwood frame shall be provided for toilet entrance and toilet internal doors shall be solid core FRP.
- f) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

3.07.00 Windows & Ventilators

Full glazed windows and ventilators shall be powder coated and UV protected aluminium window frame with 6 mm thick clear float glass and 5.5 mm thick clear wired glass where required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators. Glazing between AC and Non AC areas shall be double insulated glass. Aluminium sections shall be of heavy duty and from reputed and approved manufacturer. The window area shall be so decided as to allow adequate natural ventilation and light.

Aluminium safety grills shall be provided for all windows.

Note: Member sizes of Aluminium Glazed doors and windows/ventilators shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.

3.08.00 Landscaping

Not applicable under this package.

3.09.00 Facilities in Buildings

Adequate toilet and drinking water facilities shall be provided for personnel working in the building. The building shall have toilet facilities both for Gents and Ladies and physically challenged persons. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code.

However minimum 1 EWC and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, 2 urinal shall be provided in each toilet.

The building shall have drinking water facility connected through potable water with water cooler.

Provisions should be kept for barrier free environment for physically challenged persons like ramps in 1 in 12 slope, , toilets, etc. The main entrances of the building shall be provided with ramp.

Pantry provision should be kept for the areas which have office space, control room or the spaces which will be 24 hours manned.

3.10.00 **Potable Water System and Service water Plumbing**

This system shall be connected to the drinking water and service water systems, the scheme for which is indicated elsewhere in this specification.

Water outlets shall be provided for an instantaneous flow rate of approximately 7 Cu.M/Hr. (25 GPM).

System will satisfy state and local plumbing codes. Following I.S. Codes for the system shall be followed:

- a) IS-2065: Code of Practice for water supply in buildings.
- b) IS-1172: Code of basic requirements for water supply, drainage and sanitation.
- c) IS-1200: Laying of water and sewer lines including appurtenant items.
(Pt. XVI)
- d) IS-1239 Specification for mild steel tubes and mild steel tubular and other wrought steel pipe fittings. (10 mm to 15 mm nominal diameter).
- e) IS-3589: Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

Potable water shall be supplied to basins, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the plant sanitary sewer system.

Service water shall be supplied to water closets, urinals, sinks, and other plumbing fixtures.

3.11.00 **Roof Drainage Systems**

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure and shall consist of the following:

- a) Roof Drain Heads
- b) Rain Water Down comers
- c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this

purpose.

Adequate numbers of rainwater drains heads shall be provided for roof areas as per standard norms for roof area.

System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.

Any roof more than 8.0 metres above grade shall have access from within the building for cleaning of roof drains.

Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view.

All the drains including plinth protection drains are RCC under this package.

3.12.00 **Glazing & Glazed Partition**

- a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.
- b) 6 mm thick ground glass shall be provided for toilets.
- c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.
- d) All glazing shall be in aluminium frame having 15-micron colour powder coated.
- e) 5.5mm thick. Wired glass shall be used for windows / ventilators at higher level for safety.
- f) For glazed aluminium door, 8.0mm thick clear float glass with or without etching is to be provided

3.14.00 **Sealant**

Silicon sealant around external doors and windows / Polysulphide sealant with polystyrene filler board shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows, etc. shall be sealed for proper water- lightness.

3.15.00 **Damp Proof Course**

50 mm thick (1:1.5:3) concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.16.00 **Plinth Protection**

Minimum 1000 mm wide and minimum 100 mm thick P.C.C. M 35 plinth protection along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be provided. The plinth protection shall be laid over prepared sub-grade and base formed with two layers of locally available laterite/broken stone. Each layer shall have a pre-compacted thickness of 150 mm and consolidated to 115mm. Thus the total thickness becomes 230mm.

3.18.00 **Painting**

Exterior Masonry Surface	:	Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint over plaster (two finishing coats over one coat of primer). Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade.
Exterior Steel Work	:	For all external steel structures under civil scope : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Two finish coats of Aliphatic Polyurethane(TiO ₂) rutile of 50-60 micron each shall be applied
All Woodwork	:	Synthetic paint two coats over a coat of primer.
All Internal Steel Work	:	For all internal steel structures under civil scope : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Two finish coats of Aliphatic Polyurethane(TiO ₂) rutile of 50-60 micron each shall be applied
All Interior wall surfaces with ceiling	:	Acrylic emulsion paint two coats over one coat of primer over 3 mm wall putty.

3.19.00 **Miscellaneous Work**

- a) Window grill shall be generally powder coated aluminium grill shall be provided.
- b) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.
- c) Suitable arrangement of floor drain with trap shall be provided in floor where spillage of water or floor washing will occur.
- d) Doors, windows and rolling shutter in the building shall have sunshade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 600 mm for windows. Projections for Rolling shutter shall be 1000mm. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided.
- e) Roof access: roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.
- f) Window sill: All window sill height shall be measured from finished floor level.
- g) Lintel height: All lintel height shall be measured from finished floor level.
- h) Parapet height: The roof shall have minimum 1000mm high parapet wall. Parapet wall shall be of RCC and shall be of 125mm thickness.
- i) Internal wall height: Wall height between AC and Non AC areas as well as between two AC areas, shall be full height up to bottom of roof slab or bottom of beam.
- j) False ceiling height: Unless specifically mentioned the false ceiling height shall be 3.m within rooms and 2.7m-3.0m at corridors outside the rooms.
- k) Dado/Skirting height: Unless specifically mentioned the skirting height shall be 150mm from finished floor level and dado height shall be 100mm higher than the door opening height for toilets and kitchen / pantry.



- l) Walkways wherever required shall be of heavy duty 75 mm (minimum) thick anti-skid interlocking concrete paver blocks of approved design and top colour.

3.20.00 Watch Towers

Not applicable under this scope of work.

3.21.00 Sanitary Drainage System

- a) Diameter of Soil Pipe and Wastewater Pipe outside the building and vertical / horizontal stack connected with 8 fixtures shall not be less than 150 mm.
- b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995) for above ground level and DI pipes for below ground level.
- c) IS: 1742 - Code of Practice for building drainage & IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings should be followed.
- d) If not specified the minimum gradients of soil and drainage pipe line shall be as follows:
- | | | |
|-------------------------|---|----------|
| I. 100 mm nominal dia | : | 1 in 35 |
| II. 150 mm nominal dia | : | 1 in 65 |
| III. 230 mm nominal dia | : | 1 in 120 |
| IV. 300 mm nominal dia | : | 1 in 200 |
- e) Floor drain should have 'P' or 'S' trap connection as required.
- f) Pipe to pipe should be connected in 45° or 135° both vertically and horizontally.
- g) For cleaning purpose during maintenance, Floor Cleanout and Wall Cleanout should be provided for horizontal run and vertical run of the pipes.
- h) In no case soil pipe shall be connected to waste pipe.
- i) In vertical stack proper venting system with anti-siphonage vent pipes should be provided for all Water Closets.
- j) Drop slab of minimum 450mm depth shall be provided for the toilets where technically and aesthetically required.
- k) All plumbing and water supply fittings & fixtures, rain water drainage of



plants of any building/premises/open area within the Battery limits of this package are in the scope of this contract.

All the sewerage shall be collected and the same shall be interconnected to the Main Plant Sewer System at the nearby RCC manhole

4.00.00 DESIGN DATA FOR ARCHITECTURAL WORKS

1. Brick works – internal and external : 230 mm thick fly ash brick wall with 1:5 Cement- Sand mortar. All non-load bearing Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.

Fly ash bricks (cement bonded) shall be locally made. Bricks shall have smooth rectangular faces with sharp and square corners. Bricks shall be machine moulded and shall be made from the admixture of suitable good quality of fly ash, sand and cement as per the composition mentioned below:

FLY ASH :	50-60%
SAND :	32-40%
CEMENT :	8-12%

The fly ash bricks will be as per latest relevant IS code. The bricks will be of dimension as per standard clay brick, suitable for making 230mm thick full brick wall, 115mm thick half brick wall and 75mm thick minor partition walls, as applicable, as per drawing/specification/BOQ. A maximum tolerance of (+/-) 2mm shall be allowed as the manufacturing tolerance. The bricks shall have frog of 100 mm in length 40 mm in width and 10 to 20 mm deep of one of its flat sides.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

The bricks when tested in accordance with the procedure laid down in IS 3495 (part 2): 1992 after immersion in cold water for 24 hrs., water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. The bricks shall have a minimum crushing strength of 75 Kg/CmSq.

Chamber burnt clay bricks shall be used for any load bearing brickwork and for cladding in case of non-availability of Fly ash bricks, subject to the approval of NTPL.

2.	Half brick thick wall	:	1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.
3.	One third brick wall	:	1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.
4.	Damp proof course	:	40mm thick 1:1.5:3 Concrete with a 2% admixture of water proofing compound or as per manufacturer's recommendation.
5.	Plaster:		
	Exterior & rough side	:	20 mm thick with 1:4 cement-sand of interior brick wall mortar in two layers except where special finish provided.
	Interior	:	12 mm thick with 1:4 cement-sand mortar
	Ceiling	:	10 mm thick with 1:3 cement-sand mortar (chicken wire mesh shall be provided at the junctions between RCC-BW





etc before applying
Plastering.

6. White Cement Putty Punning : 3 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

7. False Ceiling :

Aluminium pre-painted stove enamelled finish false ceiling, either lineal panel system or aluminium tile/plank system.

- a) PANELS

Panels to be manufactured from pre-painted, stove enamelled, alloy EN-AW-5050 or equivalent (according to EN 1396 and ECCA).

Panels are to be coupled in longitudinal direction by means of panel splices.

Optionally the flange with 3 x 7 ventilation holes can be used to achieve a ventilated ceiling.

- b) SUSPENSION

Rows of 0.5 Fe/0.95 Aluminium roll formed carriers shall be installed about 1200mm centre on centre by means of adjustable suspensions about a distance of 1200mm, centre on centre. Carriers will be joined by means of carrier splices. Carriers provided with prongs to hold panels in a standard module of 100mm.

- c) PERIMETER PROFILES

- Clip-on U-profile, 28.6x12.5 x20 mm, made of 0.35 thick aluminium
- Wall L-profile, 29.2x19.4 mm, made of 0.5 mm thick aluminium
- Wall L-profile, 45x18.5 mm, made of 0.8 mm thick aluminium
- Wall W-profile, 45x21x21x18.5 mm, made of 0.8 mm thick aluminium





d) PERFORATIONS

Manufacturer shall supply panels with following perforation specifications:

- $\varnothing$ 1.0 mm, Δ 2 mm with 23% open area
- $\varnothing$ 2.0 mm, Δ 5 mm with 16% open area

Perforated panels to have a nominal plain border along the longitudinal panel direction to assure a maximum flatness and product stability:

- 84C panel, 1 mm perforated to have a plain border of 7 mm
- 84C panel, 2 mm perforated to have a plain border of 6 mm

e) ACOUSTICS

Manufacturer shall supply acoustic non-woven tissue, thickness 0.2 mm factory applied inside the panels. Alternatively the installer can place individual PE wrapped mineral wool pads.

f) COATING

The coating will consist of a tough and durable polyester finish in nominal thickness of 20 microns, applied in a continuous coil-coating process ensuring uniform coating and absolute adhesion.

g) INSTALLATION

All materials shall be installed by the approved applicator/erector of the manufacturer under supervision of the authorized representative of the manufacturer.

8. Floor finish:

- a. Generally finish to utility areas shall be 50 mm thick heavy-duty granolithic flooring with metallic hardener on concrete slab.

The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B & C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile strength of concrete in terms of its adhesive bond



strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of the layer to be done with non-degrading membrane forming curing & sealing compound shall be acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m² in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

- b) For special areas like control room, offices etc. shall have 10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.
- c) Chemical resistant floor (if required)

For battery room, battery charger room etc. the areas handling corrosive liquids, overall 50 mm thick Chemical resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Chemical resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

- d) Wet area flooring

All areas of toilet, including W.C and urinal shall have antiskid vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

- e) Floor/staircase and the areas prone to slippage due to oil spillage etc. shall be provided with non-skid floor finish.
- f) For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 shall be applied in front of equipment.

- 9. Doors & windows The building shall be provided with minimum 15 micron pre-coated i.e. colour powder coated aluminium

glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

- a. In general area shall have hollow metal steel door with or without vision lite
- b. Doors of W.C. and shower shall be hard core FRP door.
- c. Full glazed windows and ventilators shall be powder coated and UV protected aluminium window frame with 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators. Glazing between AC and Non AC areas shall be Double insulated glass. Aluminium sections shall be of heavy duty and from reputed and approved manufacturer. Windows and ventilators shall be fabricated and painted by the reputed fabricators at their own fabrication shop. Windows shall be glazed aluminium windows conforming to IS: 1949 & IS: 1948.

10. Rolling Shutters:

Rolling shutters as per IS: 6248 with electrically operating arrangement according to size shall be provided in buildings to facilitate handling and transportation of equipment for large openings from 9.0 sqm and above. Wherever truck entry is envisaged, minimum size of rolling shutter size shall not be less than 3.5m (W) x 4.0m (H).

The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanised steel lath section of 18swg tested mild steel strips at 75mm rolling centres, locked with galvanised malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3mm thick galvanised steel plate and security riveted with stiffening angles.

11. Glazing:

- a. Glazing for windows in general shall be minimum 6 mm clear float glass and as mentioned elsewhere in this document.
- b. Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.
- c. Minimum 8.0 mm thick toughened float glass as specified

below shall be provided in doors, partitions.

- d. 24mm thick insulated double glazing having 6mm thick tinted heat- reflecting type outer float glass and 6mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on powder coated aluminium frame suitable for structural glazing system. Quality of glass is given below.
- 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside – 11%, Total Solar Energy Transmittance – 66% Reflectance–10% UV transmission – 49%, Solar Heat Gain Coefficient – 0.70 Shading Coefficient – 0.81 ,U – Factor Air 2.77 W/m²k , Sound Insulation – 31db outer lite.
 - 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside – 30 %, Total Solar Energy Transmittance – 19%, Reflection – 9%, UV – 9 %, Solar Heat Gain Coefficient – 0.29 Shading Coefficient – 0.33,U –Factor Air – 1.9 W/m²k, Sound Insulation – 33db outer lite (# 2 surface) Glass with a combination of 6 mm thick toughen Optifloat clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

12. Roof waterproofing :

After curing of the concrete, the roofs of building shall be provided with 3 layers, first being minimum 1.5mm thick elastomeric membrane waterproofing treatment coating with $\geq 500\%$ elongation confirming to ASTM C836 applied by a spray/brush/roller in two coats, secondly 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating over which screed concrete (of M20 with 12mm blue metal chips) shall be laid and finally the wearing course. 1.5mm thick Elastomeric membrane shall be laid as per manufacturer's specification. Run off gradient shall be given a minimum of 1 in 100. Gradient shall comprise screed concrete M20 using 12.5 mm or below coarse aggregate and waterproofing treatment as per IS:2645, mixed with polypropylene fibres. Over the screed concrete wearing course treatment shall be provided as below:

A wearing course shall consist of pressed clay tiles of size 230x230x18 mm minimum laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing

compound.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar (cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For vertical surfaces (Parapet)

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls (2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person.

- b) For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.
- c) DI pipes of 150mm dia minimum conforming to relevant BIS Code shall be provided to drain off rainwater from the roof.. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527.

13. Painting:

- a) External masonry surfaces of all buildings shall be finished with External Quality waterproof Acrylic Emulsion paint over plaster.
- b) Acrylic internal emulsion paint of shall be provided in all interior surfaces of the building.
- c) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid (if required) shall be painted with chemical resistant paint.

14. Water Supply and Sanitation :

- a) HDPE roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building.
- b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type.
- c) DI pipes shall be used for sanitary work below ground.
- d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.
- e) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995) for above ground and DI pipe for below ground.
- f) Toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided
 - Water closet – Indian & European type.
 - Large flat back urinal with marble slab divider.
 - Wash basin – Oval shaped Counter-top (Granite) wash basin.
 - Minimum 500 mm long Chromium plated towel rail.
 - Chromium plated liquid soap holder.
 - Chromium plated toilet paper roll holder.
 - Robe hooks
 - Minimum 750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor, shall be mounted on PVC sheet.
 - Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc.

shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval. However minimum 1 EWC and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, 2 urinal shall be provided in each toilet.

Note Toilets for physically-challenged persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

15. Under-Deck Insulation

- a. Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- b. Density of Material shall be between 40 to 60 Kg/m³
- c. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m²K at an average temperature of 0°C
- d. The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category. Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.
- e. Under-deck insulation shall be provided for all AC areas having roof exposed to sun/floor exposed to heat atmosphere.
- f. Thickness:
 - o For Concrete Slab: 25 mm thick sheet is used
 - o For Corrugated or metal ceiling: 32 mm thick sheet

16. Sealant:

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation having weathering resistance to ultraviolet ray property. The product shall exhibit **shore 'A' hardness of 25** and have **movement accommodation factor of 25%**. The sealant must comply with the performance specifications as laid in **BS: 4254 and ASTM C 920**. All the joints must be primed using compatible primer for the substrate from the equal or similar to MASTERFLEX PRIMER range of BASF. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.

2. Polyurethane based single component joint sealant materials based upon polyurethane resins. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm² and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600 % and recovery of 80%.

17. Statutory rules:

- a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC) / Loss Prevention Association (LPA), and Water Act for pollution control etc.
- b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.
- c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. Shall be made according to the recommendation of Loss Prevention Association of India / Tariff Advisory Committee.
- d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.



**Tender Specification
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Chimney**

**NLC Tamil Nadu Power Ltd.
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VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: IV

**GUIDELINE
FOR
MASONRY AND ALLIED WORK**



Development Consultants Pvt. Ltd.

**Volume: II-B
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Masonry and Allied Work**



**Tender Specification
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Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	I. S. CODES	6



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: IV
Masonry and Allied Work**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: IV

**GUIDELINE
FOR
MASONRY AND ALLIED WORK**

1.00.00 SCOPE

This specification covers furnishing, providing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.02.00 Masonry

2.02.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.02.02 Mortar

Mix for mortar shall be specified..

For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.





Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

2.02.03

Brick Masonry

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. For brick work in half brick wall, bricks shall be laid in stretcher bond. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar. At the joint of brick masonry with RCC column/beam/wall, the mortar shall be with rich grade to avoid shear cracks.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. The inside face of the brick work shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.02.04

Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from



routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.02.05 Reinforced Brickworks

Reinforcements shall be as specified.. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.02.06 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and as specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.02.07 Moldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.02.08 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.02.09 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.03.10 Encasing of Structural Steel

This shall be done by building masonry work, around flanges, webs etc. of steel members and filling the gap between steel and masonry by minimum 12 mm thick rich mortar. Encased members shall be wrapped with minimum 18G chicken wire mesh when shown on drawings or instructed by the Engineer, before plastering work.

The minimum lap in chicken wire mesh shall be 50 mm.





2.03.11 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 50 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are: -

IS : 1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS : 2185	:	Code Practice for hollow concrete block.
IS : 1597	:	Code of Practice for Construction of stone Masonry.
IS : 1609	:	Code of Practice for laying Damp-proof treatment Using bitumen felts.
IS : 2212	:	Code of Practice for Brickwork.
IS : 2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS : 5134	:	Bitumen Impregnated Paper & Board.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: V

**GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: V
Finish to Masonry and Concrete**



**Tender Specification
for
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CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	ACCEPTANCE CRITERIA	9
4.00.00	I. S. CODES	9



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: V
Finish to Masonry and Concrete**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: V

**GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE**

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Bidder shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purpose shall be filled and made good before plastering.

Note : In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

2.01.01 Preparation of Surface





The cement plaster shall be 6 mm, 10mm, 12mm, 15mm, 18mm or 20mm as specified.

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 Plastering

2.02.01 Mortar

Mortar for plastering shall be as specified in the specifications.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Ceiling plaster shall be completed before commencement of wall plaster.

Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true





surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working or over working the float shall be avoided.

All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not to nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in the plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Thickness

Where the thickness required as 20mm, the average thickness of the plaster shall not be less than 20mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15mm while in case of stone work the minimum thickness over the bushings shall be not less than 12mm.

Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the Bidder's expense by such means as the Engineer-in-Charge may approve. The dates on which



the plastering is done legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

2.02.03

Finish

The plaster shall be finished to a true and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Precaution

Any cracks which appear in the surface and all portions which sounds hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

- i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm drawn with any suitable method with the wall while the plaster is green.
- ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150mm wide chicken wire mesh should be fixed with U nails 150mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall not be made separately.
- iii) Due to faulty construction, if the plaster thickness increases more than 20 mm, the Bidder shall provide chicken mesh to hold the plaster, at his own cost.

Cement Plaster with a Floating coat of Neat Cement

The cement plaster shall be 6mm, 10, 12, 15, 18mm or 20mm thick, finished with a floating coat of neat cement, as described in the specification.

Specifications for this item of work shall be same as described above except for the additional floating coat which shall be carried out as below.

When plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a pest of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quality of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in





no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in above shall apply.

18mm/20 mm Cement Plaster (Two Coat Work)

The specification for scaffolding and preparation of surface shall be as described above.

Mortar

The mix and type of the aggregate specified in the description of item shall be used for the respective coats. Generally the mix of the finishing coat unless otherwise described in the item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat , unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

Application

The plaster shall be applied in two coats i.e. 12 mm under coat and then 6/8mm finishing coat and shall have an average total thickness of not less than 18/20mm.

12mm under coat

This shall be applied as specified earlier except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

6/8 mm finishing coat

The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified earlier.

Specifications for curing, Finishing and Precautions shall be as describe earlier.

6/10 mm Cement Plaster on Cement Concrete and Reinforced Cement Concrete Work

Scaffolding

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

Preparation of Surface





Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing of not more than 5 cm. Centers, the pock being made not less than 3mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

Mortars

Mortar of the specified mix using the types of sand described in the item shall be used.

Application

To ensure even thickness and true surface, gauges of plaster 15 x 15 cm. shall be first applied at more than 1.5m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then be applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Thickness

The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5mm.

Curing

The specification as stated earlier





Precautions

The specification as stated earlier

2.02.04 Other Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. or as per schedule and shall be rubbed smooth with a trowel.

2.03.00 Pointing to Masonry

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be



applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.05.00**White Cement Putty Punning**

Plastered surfaces, where specified shall be finished with White Cement Putty punning. The material shall be from approved manufacturers and approved by the Engineer. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 sq.m. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

PROPERTY

1.	Tensile Adhesion Strength (N/MM ²) @ 28 Days	> 1.0
2.	Compressive Strength (N/MM ²) @ 28 Days	> 9.0
3.	Setting Time (Minutes) - Initial Final	=> 100 =< 500
4.	Water Absorption Coefficient - Kg/M ² .H ^{1/2}	< 1.0
5.	Water Capillary Absorption (ML) @ 24 Hrs.	0.8
6.	Water Retentivity %	> 98

Surface Preparation

All loosely adhering materials on the plastered wall surface is to be removed with the help of emery stone, putty blade or wire brush and clean water. The substrate should be cleaned, free from dust, grease and loose materials. Dry and absorbent surface should be moistened with sufficient quantity of clean water.

Mixing

White cement putty should be mixed slowly with 30-35% of clean water to form a paste. Mixing is to be continued for 10-15 minutes to form a uniform paste.

Application method



First coat shall be applied on well moistened plastered wall surface from bottom to upward direction uniformly with putty blade. After drying of first coat the surface shall be rubbed gently with wet sponge or putty blade to remove loose particles. Surface shall be allowed 3 hours to dry before applying the second coat. After complete drying of second coat, loose particles shall be removed by gently rubbing the surface with wet sponge or putty blade. After mixing the putty should be utilized within 2 hours. Total thickness of coats shall not be more than 1.5mm or as per manufacturer specifications.

2.06.00 Cement Water Proofing Compound

It shall be used for cement mortar for plastering or concrete work.

Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacturer, enlisted by the Engineer-in-Charge from time to time shall be used.

The Bidder shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added. It shall be measured by weight.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I. S. CODE

Important relevant code for this Section:

- a) IS : 1661 : Code of practice for cement and cement-lime plaster finish on walls and ceilings.
- b) IS : 4101 : Code of practice for external facings and veneers.
- c) IS : 1200 (Pt-XII): Method of Measurements of Building and Civil Engineering Works: Part: XII-Plastering and Pointing





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: VI

**GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES,
ETC.**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: VI
Metal Doors, Windows, Ventilators, Louvres,
Curtain Wall, Structural Glazing, etc.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	INFORMATION TO BE SUBMITTED	7
5.00.00	I. S. CODES	7



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: VI
Metal Doors, Windows, Ventilators, Louvres,
Curtain Wall, Structural Glazing, etc.**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: VI

**GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES ETC.**

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete including supply of glass and glazing. The scope of work shall also include the assembly at site and erection of all doors, windows, louvers, glazed partitions, etc. for which fabricated materials. Supplying and fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 733 and 1285 for chemical composition and mechanical properties. The stainless steel screws shall be grade AISI 304. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified in "Schedule of Fixtures" and the best quality from approved list of manufacturers shall only be used. The successful bidder shall specifically state the list of manufacturer's materials he proposes to use. "Schedule of Fixtures" is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to





inadequate strength of hardware or fixture shall entirely be the Bidder's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in the specification. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix- A.

The Bidder shall submit **three** samples of each type of hardware to the Engineer for approval. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Bidder towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.02.00 **Fabrication**

2.02.01 **Steel Doors, Windows, Ventilators, Louvers, etc.**

a) **Door Frames**

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) **Double Plate Flush Door Shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have





proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

The manufacturing shall be done as specified in "Double Plate Flush Door Shutters".

2.02.02 Aluminium Door, Windows and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

Where required factory made evenly baked powder coated coloured aluminium extruded sections shall be used. DFT shall not be less than 0.8 mils. Colour shall be as per Colour Schedule or as per instruction of the Engineer-in-Charge.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by





such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.06.00 Shop Coat or Paint

The shop paint for steel doors, windows, etc. shall be best zinc ethyl silicate primer paint from approved manufacturer conforming to IS 2074. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc ethyl silicate primer.

2.07.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Bidder shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.08.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 and as shown on drawings. The Bidder shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like





**Tender Specification
for
Chimney**

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2x500 MW Project
Tuticorin, Tamil Nadu**

manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Bidder shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Bidder and made good again as per original, after installation

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Bidder shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Bidder mastic shall be supplied by the Bidder and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For Fabricated Items

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.





- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.
- h) Provisions for hardware and fixtures to be installed at site.
- l) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.02.00

For Installed Items

- a) Installations shall be at correct location, elevation and in general on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.





4.00.00 **INFORMATION TO BE SUBMITTED**

4.01.00 **After Award**

- a) Names of manufacturers for doors, windows, etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.
- c) Before starting fabrication of all metal doors, windows, etc. the Bidder shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.
- d) He shall submit a programme of work to be done for the approval of the Engineer.
- e) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Bidder towards the end for final incorporation in the job.

5.00.00 **I.S. CODES**

Following are some of the important I.S. Codes as relevant to this section :

Steel doors, windows and ventilators	-	IS : 1038
Steel windows for industrial buildings	-	IS : 1361
Aluminium doors windows and ventilators	-	IS : 1948
Aluminium windows for industrial buildings	-	IS : 1949
Steel doorframes	-	IS : 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS : 1081
Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineer Purposes) – Specification	-	IS : 733
Wrought Aluminium and Aluminium Alloy sheet, and strip for General Engineer Purposes - Specification	-	IS : 737





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) –Specification	-	IS : 1285
Anodic coating on Aluminium and its Alloys – Specification	-	IS : 1868
Specification for Aluminium equal leg angles	-	IS : 3908
Specification for Aluminium unequal leg angles	-	IS : 3909
Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.	-	IS : 3965
Method of testing anodic coating on aluminium and Its alloys	-	IS : 5523
Measurement of coating thickness by Eddy Current Method	-	IS : 6012
Floor springs (Hydraulically regulated) for heavy doors Specifications		IS : 6315
Dimensions of extruded hollow section and tolerances	-	IS : 6477





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: VII

**GUIDELINE
FOR
ANTI-TERMITE TREATMENT**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: VII
Anti-Termite Treatment



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	EXECUTION	1
3.00.00	I. S. CODES	4



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: VII
Anti-Termite Treatment**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: VII

**GUIDELINE
FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to prevent the subterranean termites from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites while the building is under construction. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

2.02.00 Safety Precautions





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption through skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.03.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (20EC) (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable (20EC) Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable (20EC) Concentrate (IS: 2682 - 1984)	: 1.0
Lindane (20 EC) (IS: 632)	: 1.0

2.03.01 Treatment

To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the





required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites shall be done as per IS 6313 (Part III).

2.03.02 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (up to a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M² of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to sock the soil below at the rate of 2.25 litres per linear metre.

2.03.03 **Treatment of Top Surface of Plinth Filling**

Holes 50 cm to 75 cm deep at 100 cm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.03.04 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 cm and a depth of 75 cm at the point where they enter the building.

2.03.05 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.03.06 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

300 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981	:	Code of Practice of Anti-Termite Measures in Buildings (pre-constructional)
IS : 632	:	Gamma-BHC (Lindane) emulsifiable Concentrates
IS : 8944 – 1978	:	Chlorpyrifos emulsifiable concentrates
IS : 8963	:	Chlorpyrifos- Technical specifications
IS : 6439 – 1978	:	Heptachlor Emulsifiable
IS : 2682 – 1984	:	Chlordane Emulsifiable
Pre-constructional chemical treatment measures.		





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: VIII

**GUIDELINE
FOR
ROLLING STEEL SHUTTERS, GRILLS
AND COLLAPSIBLE DOORS**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: VIII
Rolling Steel Shutters, Grills and
Collapsible Doors



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I. S. CODES	5



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: VIII
Rolling Steel Shutters, Grills and
Collapsible Doors**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: VIII

**GUIDELINE
FOR
ROLLING STEEL SHUTTERS, GRILLS
AND COLLAPSIBLE DOORS**

1.00.00 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters with motor drive operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick of CR grade for shutters upto 4.5 M wide and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats
- c) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- d) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M
- e) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- f) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.





- g) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. .
- h) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

- i) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.
- j) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00

Power Operated Shutters

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in , externally mounted shutters shall be operated by control mechanism located inside the building.

2.03.00

Rolling Shutters

Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitably fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type/Mechanical and electrically operated

Shutter : The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90mm for the shutters up to 3.5m width and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure of 100 kg/sq.m. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure.





Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

Spring : The spring shall be coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454 - Part I.

Roller and Brackets : The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161 to carry the torsional load with a maximum deflection of $1/360^{\text{th}}$ of span. For shutter up to 6 metre width and height not exceeding 5 metre, steel pipes of 50mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters up to clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5m and up to 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5 mtr, the cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearings with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15 mm and at least 4 number flats running throughout length of roller shall be provided.

In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

Guide Channel : The width of guide channel shall be 25mm the minimum depth of guide channels shall be as follows :

Clear width of shutter	Depth of guide channel
Up to 3.5 m	65mm
3.5m up to 8m	75mm
8m and above	100mm

The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.



Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

Cover : Top cover shall be mild steel sheets not less than 0.90mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

Power unit : Power unit shall be suitable for 3 phases, 50 cycles, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building. It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

Fixing : The arrangement for fixing in different situations in the opening shall be as per IS 6248.

Brackets shall be fixed on the lintel or under the lintel as specified with rawl plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and brackets shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in workmen like manner that the operation of the shutter is easy and smooth.



2.04.00 Shop Coat

Shutters shall be painted with one coat of zinc ethyl silicate primer. the finish coat shall be as per SS III/part C/sec I/vol II B

2.05.00 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the successful Bidder shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

4.00.00 I.S. CODE

IS : 6248 - Metal rolling shutters and rolling grills.



Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART- C

SUB SECTION: IX

**GUIDELINE
FOR
GLASS AND GLAZING**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: IX
Glass and Glazing



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	ACCEPTANCE CRITERIA	6
4.00.00	I. S. CODES	6



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: IX
Glass and Glazing**



**VOLUME: II-B
SECTION: I**

PART- C

SUB SECTION: IX

GUIDELINE

FOR

GLASS AND GLAZING

1.00.00 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall be included in this scope.

2.00.00 INSTALLATION

2.01.00 General

The Bidder shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions from approved manufacturer, shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

- a) Clear glass shall be float glass and should be approved by the Engineer-in-Charge and shall be at least 6 mm thick for windows and for doors & glazed partitions shall be minimum 8mm thick or as indicated in doors' and windows schedule. It shall be clear, float transparent toughened and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900. The thickness of float glass shall be measured with micrometers or a calliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.
- b) Wired glass of 5.5mm thick minimum shall be provided for all buildings except office rooms, control rooms and A/c rooms.
- c) Obscure glass shall have a cast surface in one side.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- d) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.
- e) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.
- f) The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The Bidder shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table below :

SL. No.	Description	Standard Follow	Specification
1	Tensile strength kg.f/cm ²	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kgf/cm ²	ASTM-D 412	22 Min.
4	Compression set % at 0° CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

Quality of glass

- a) All glass shall comply with ECBC 2007 requirements.
- b) Single glass panels shall have properties like –
VLT = 35 to 50%, external reflection=6 to 15%, internal reflection=8 to 15%, solar factor=0.36 to 0.43, U value=2.8 to 3.0 W/sqm K to be provided.
- c) Double glazed panels with glass having properties like-
VLT = 30 to 45%, external reflection=8 to 20%, internal reflection=15 to 30%, solar factor=0.26 to 0.29, U value=1.8 to 1.9 W/sqm K. shall be provided.





2.02.00 Reflective Glass

Definitions

- i) **Shading Coefficient** : The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.
- ii) **Luminous Efficiency Constant (Ke)** indicates a windows relative performance in rejection solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near-infrared energy has a Ke close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Ke of about 2.0.
- iii) **Resistance to Heat Conduction (R-value)** : It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

2.03.00 Glazing, Setting and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Bidder.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Bidder.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Bidder. The Bidder shall be responsible for damage of glass , during handling, transportation, fixing etc.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

After completion of glazing work, the Bidder shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Bidder's own cost.

3.00.00 ACCEPTANCE CRITERIA

- a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 IS CODES

Following are some of the important I.S.Codes relevant to this Section;

- IS : 3548 - Code of practice for glazing in building.
- IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.
- IS : 14900 - Transparent Float glass - Specifications.





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: X

**GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: X
Floor Finishes and Allied Works



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	2
3.00.00	ACCEPTANCE CRITERIA	10
4.00.00	I. S. CODES	11



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: X
Floor Finishes and Allied Works**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: X

**GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS**

1.00.00 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below:

a) In Situ Finishes

- Metallic Hardener like “Ironite” or equivalent finish

b) Tiled Finishes

- Pressed Ceramic Tile Flooring (Vitrified Tile Flooring)
- Pressed Ceramic Tiles In Skirting And Dado
- Chemical Resistant Tiled Finish
- Anti-Static PVC Flooring

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.02.00 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Bidder for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.





2.00.00 **INSTALLATION**

2.00.01 **Special Materials**

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 **Workmanship**

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires that the Bidder shall get the finishing items installed by the manufacturer.

2.00.03 **Preparation of the Base Surface**

The surface to be treated shall be thoroughly examined by the Bidder. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.



2.01.00 **In Situ Finishes**

2.01.01 **Cement Concrete Flooring with Metallic Hardener Topping**

Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardener is justified on the basis of cost.

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) **Thickness**

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth (top layer of 50mm thick floor finish).

b) **Material**

The hardening compound shall be of approved quality consisting of uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) **Mix**

The top layer shall consist of 12mm thick layer of mix 1: 2 (1 cement: 2 stone aggregate 6mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1:4 (1 metallic concrete hardener: 4 cement) by weight or as per manufacturer's specification relevant to medium/heavy duty floor. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6mm nominal size or as otherwise specified in the ratio of 1:2 (1 cement :2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

d) **Laying**

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The mixture so obtained shall be laid in 12mm thickness, on cement concrete floor while the concrete under bed is still very "green" within 2 to 4 hours of it's laying. The topping shall be laid true to provide a



uniform and even surface without trowel marks, pin holes etc. It shall be firmly pressed into the bottom concrete so as to have good bond with it. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.02.00 **Tiled Finish**

These shall include vitrified tiles, over already laid and matured base of concrete by means of an underbed or an adhesive layer.

2.02.01 **Pressed Ceramic Tile Flooring (Vitrified Tile Flooring)**

Tiles shall conform to Table 12 of IS and the joint thickness in flooring shall not be more than 1mm.

a) **Materials : Vitrified Tiles**

The tiles shall be of approved make and shall generally conform to the approved standards. They shall be flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as per drawings or as directed by the Engineer-in-Charge. Thickness shall be as per recommendations of the approved manufacturers. However the floor tile thickness shall not be less than 10mm and the overall thickness of the floor finishing shall be 50mm.

Technical specifications of the tiles shall be generally conforming to the following standards:

Technical Specifications For Vitrified Tiles

No.	Property	Expected Standards
1	Deviation in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	< 0.50%
6	Mohs. Hardness	> 6





7	Flexural strength	> 27 N / mm ²
8	Abrasion resistance	< 204 mm ²
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness Min.	85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

b) **Preparation of Surface for Flooring**

Following procedure shall be followed :

- **Sub grade**

Concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

- **Mortar and bedding**

Cement mortar for bedding shall be prepared of mix 1:4 or as specified. to a consistent paste and shall conform to the specification for materials; preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water.

Apply on an average 20 mm thick bedding of mortar over an area of 1 sqm at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

c) **Laying Of Tiles for Flooring**



The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown / directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall / floor. White cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile. Do not use an iron hammer or some heavy material to press the tile. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white / matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

d) **Fixing Tiles for Dado & Skirting**

The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

DAE / DCSEM: 102: SPN-CVL

The back of tiles shall be cleaned off and covered with layer of approved adhesive like BAL-ENDURA or equivalent with proper trowelling as per manufacturers recommendations.

The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials.



The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

e) **Grouting Of Joints In Floor / Skirting / Dado**

The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like BAL-ENDURA or equivalent grouts.

After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

f) **Cleaning**

As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

g) **Cleaning Agents for Vitrified Tiles**

Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

Cleaning Agents for Vitrified Tiles

Stains	Cleaning Agent
Robin Blue	Household detergent / Warm water
Marker ink	Turpentine / Acetone / Trichloroethylene
Pen ink	Acetone / Isopropyl alcohol
Methylene blue	Isopropyl alcohol / Acetone
Sauce	Ammonia solution
Cement	Turpentine / Acetone / Trichloroethylene / Conc. HCL
Tea	Hydrochloric acid / Bleaching powder
Coffee	Sodium hydroxide / Potassium hydroxide
Beer	Sodium hydroxide / Potassium hydroxide
Diesel	Acetone / Petrol



Lab indicator	Acetone / Isopropyl alcohol
Cement and grouting	Hydrochloric acid
Pencil mark	Benzene or Toluene or Xylene
Plaster of Paris (POP)	Ammonium sulphate solution

Stains

Iodine (Tincture iodine)
Hair dye
Paan
Marker pen

Cleaning Agent

Sodium hydroxide / Potassium hydroxide
Per chloric acid
Lemon juice or citric acid
Acetone

2.02.02

Pressed Ceramic Tiles In Skirting And Dado

The tiles shall be approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze or more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only up to 50% of the surface area of edges.

The glaze shall be free from welts, chips, craze specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

Dimensions and Tolerances

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5, & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when joined together (with 1mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs and capping beds shall be





of the shape and dimensions as required and thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surface

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying

12mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and joined. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (swan) to the required size and their edges rubbed smooth. Skirting/ dado shall not project from the finished "surface of wall" by more than the thickness, undulations if any shall be adjusted in wall.

Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

2.02.03 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.





Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm². The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.04 **Anti-Static PVC Flooring**

PVC flooring of 2mm thick should be of approved make & brand with scratch proof, flexible & impregnated polyurethane reinforced (PUR) permanently static conductive Vinyl sheet, consists of impregnated polyurethane homogeneous mixture of PVC, plasticizers, urethane, colour pigments and filler calendared of approved colours and pattern detail. The material should be fixed with synthetic acrylic adhesive after preparing the floor, leveling & smoothening when necessary with suitable putty, as per the design & instruction of the Engineer-in-charge. Electrical resistance should be min R10⁸ ohm as per ESD approval, SP-method 2472. Anti-static sheets should be confirming clean Room Test Class A as per ASTM F 51/100.

3.00.00 **ACCEPTANCE CRITERIA**

The finish shall be checked specially for :

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability



4.00.00 **I.S. CODES**

Important relevant codes for this section:

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.
IS: 4457	:	Specification for ceramic unglazed vitreous acid resisting tiles
IS: 4441	:	Code of practice for use of silicate type chemical resistant mortars.
IS: 4443	:	Code of practice for use of resin type chemical resistant mortars.
IS: 4832 (part I)	:	Specification for chemical resistant mortar: silicon type.
IS: 4832 (part II)	:	Specification for chemical resistant mortar: resin type.
IS: 4832 (part III)	:	Specification for chemical resistant mortar: sulphur type.
IS: 13753	:	Specification for dust pressed ceramic tiles with water absorption of E>10%
IS: 13755	:	Specification for dust pressed ceramic tiles with water absorption of 3%, E6% (Group B11a)



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: XI

**GUIDELINE
FOR
PAINTING, POLISHING ETC.**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: XI
Painting, White Washing & Polishing**



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2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	PAINTING	3
4.00.00	PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES	5
5.00.00	PAINTING RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS	8
6.00.00	PAINTING WITH WOOD PRESERVATIVE	9
7.00.00	COAL TARRING	9
8.00.00	SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE	10
9.00.00	SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE	11
10.00.00	INTERNAL WALL PAINTING WITH ACRYLIC EMULSION PAINT	12
11.00.00	PAINTING WITH ACID PROOF PAINT	13
12.00.00	PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT	13
13.00.00	FRENCH SPIRIT POLISHING	14
14.00.00	EPOXY COATING/PAINTING	17
15.00.00	ACCEPTANCE CRITERIA	16
16.00.00	I. S. CODES	16



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**VOLUME: II-B
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**GUIDELINE
FOR
PAINTING, POLISHING ETC.**

1.00.00 SCOPE

This specification covers painting, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, pipes, and other ferrous and non-ferrous metal items as shown on drawings, or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Bidder shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting Bidder shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting Bidder shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. Bidder shall keep record of number of coats of painting. Before applying second coat, the Bidder shall obtain prior approval of Engineer in Charge

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be Grade-1 quality from well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained from the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

Exterior Painting on Wall

Material : The paint shall be (Textured exterior Emulsion paint / Acrylic smooth exterior Emulsion paint / premium acrylic smooth exterior Emulsion paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the Bidder 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 material shall be kept in the joint custody of the Bidder 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 :

Base coat of water proofing cement paint – All specifications in respect of base coat of water proofing cement paint shall be as described before.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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 portable 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.

The specifications in respect of scaffolding and protective measures shall be as describe before.

3.00.00

PAINTING

Materials

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the Bidder in their 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 Bidder and the Engineer-in-Charge. The empties shall not be removed from the site of the work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Commencing Work

Painting shall not be started until the Engineer-in-Charge has inspect the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application

Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, to or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by through ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need to be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint dose not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

4.00.00 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

Primer for plaster / wood work / Iron & Steel / Aluminium surfaces shall be as specified below.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Table-2

Sl. No	Surfaces	Primer to be used
1. 2. 3. 4.	Wood work (hard and soft wood) Resinour wood and plywood (A) Aluminium and light alloys (B) Iron, Steel and Galvanized steel Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	As specified in elsewhere in the specification

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

- i) **White Lead** : The white lead shall be pure and free from adulterants like barium sulphate and whiting. It shall confirm to IS 103.
- ii) **Red Lead**: This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall confirm to IS 102.
- iii) **Raw Linseed Oil**: Raw linseed oil shall be lightly viscous bit clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little small. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall confirm in all respects to IS 75. The oil shall be of approved brand and manufacture.

- iv) **Double Boiled Linseed Oil**: This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a





temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall confirm to IS 533.

All the above materials shall be approved manufacture and brought to site in their original packing in sealed condition.

4.01.00 **Preparation of Surface**

4.01.01. **Wooden Surface :** The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material confirming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

4.01.02. **Iron and Steel Surface :** All rust and scales shall be removed by scrapping or by brushing with wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

4.01.03. **Plastered Surface :** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

Application





The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described before.

Treatment on Steel for Aggressive Environment

A second coat of ready mixed zinc ethyl silicate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat is to be applied after placing the member in position and just before applying Paint.

5.00.00 PAINTING RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified

Painting New Surface

Preparation of Surface : The surface shall be prepared for priming coat as described earlier.

Application : The number of coat of painting over the priming coat shall be as stipulate in the description of the item. The application of Paint over priming coat shall be carried out as specified above.

Painting on Old Surface

Preparation of Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application : The specifications for application shall be as described earlier.

6.00.00 PAINTING WITH WOOD PRESERVATIVE





Oil type wood preservative of specified quality and approved make, confirming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

Painting on New Surface

Preparation of Surface : Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

Application : The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

7.00.00

COAL TARRING

Coal tar of approved manufacture confirming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

Coal Tarring on New Surface

Preparation of Surface : This shall be done as specified in 4.01.00 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

Application : The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitable done to ensure this.

Coal Tarring on Old Surface





The work shall be done in the same manner as specified above (Coal Tarring on New Surface) except that only one coat using 0.12 litre per sqm. area shall be done.

8.00.00

SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE

The work shall include a priming coat of 'Distemping Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completions, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application

Priming Coat : The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

Painting Coats : When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with every fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.





If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish.

If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture.

Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

9.00.00 SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE

Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

The flat wall Paint shall be of approved brand and manufacture and of required shade.

Preparation of Surface

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down tightly.

Application

The paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

10.00.00 INTERENAL WALL PAINTING WITH Acrylic EMULSION PAINT

These Paints are to be used on internal surfaces except wooden and steel.





Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application : The number of coats shall be as stipulated in the specification. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Precautions

- a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.

Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

- b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

Painting on Old Surface

Preparation of Surface : This shall be done, generally as specified in 4.01.01 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.





Application : The number of coats to be applied shall be as in description of item. The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Except the above the thinning with water shall not normally be required.

11.00.00 PAINTING WITH ACID PROOF PAINT

Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

Preparation of surface and application shall be as specified in earlier clauses for new/old surface as the case may be.

Other details shall be as specified in earlier clauses as far as they applicable

12.00.00 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

Ready mixed Paint (confirming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

Preparation of surface and application shall be as specified in previous clauses for Painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

Other details shall be specified in earlier clauses as far as applicable.

13.00.00 FRENCH SPIRIT POLISHING





Pure shellac confirming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready-made polish confirming to IS 348 can also be used.

Polishing New Surface

Preparation of Surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application : The number of coats of polish to be applied shall be as described in the item.

A pad of wooden cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly dampened with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

Other details shall be as specified in earlier clauses as far as they are applicable.

Polishing Old Surface

Preparation of Surface : If the old polished surface is not much solid it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to be done like new work and will be paid for as such.

Application : The specifications shall be same as described above and as far as applicable.



Other details shall be as specified in earlier clauses as far as they are applicable.

14.00.00 **EPOXY COATING/PAINTING**

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

14.01.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

14.02.00 **Cleaning up**

In addition to provisions in general conditions the Bidder shall, upon completion of painting etc. remove all marks and make good surfaces, where





paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

15.00.00 **ACCEPTANCE CRITERIA**

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

16.00.00 **I. S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS: 348	:	Specification for French polish
IS: 427	:	Specification for Distemper, dry colour as required.
IS: 428	:	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS: 2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS: 2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS: 2932	:	Specification for enamel, synthetic, exterior, type-I.
IS: 5410	:	Specification for cement paint, colour as required.





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: XII

**GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: XII
Roof Water Proofing, Insulation & Allied Works



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES & STANDARDS	5



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**Volume: II-B
Section: I; Part C; Sub Section: XII
Roof Water Proofing, Insulation & Allied Works**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: XII

**GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**

1.00.00 SCOPE

This specification covers providing, furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract. Roof water proofing shall be followed as specified in Sub Section III of Vol-IIB Sec-I, Part-C. However the following section gives the methods of waterproofing for general guidance.

2.00.00 INSTALLATION

2.01.00 Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to take the fiber cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

2.01.01 There is no necessity of hacking the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

2.01.02 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

- 2.01.03 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 Concrete

The concrete shall be used where the sub-grade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable. The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 Insulation

The successful bidder shall furnish specification of insulating materials he proposes to use and the proposed method of laying to the owner for approval. Before bulk supply, the Bidder shall send samples of insulating material to the Engineer, and after approval of the samples, the Bidder shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Bidder shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.07.00 Elastomeric Membrane

2.07.01 Primer Coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per liter depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.07.02

Finishing Coats

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform joint less elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by at least 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.07.03

Surface Finish

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3 (using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound to ensure perfect waterproofing.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS: 13801 shall be provided. The tiles shall be laid as per IS 1443.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

2.08.00 Under Deck Insulation

- 2.08.01 Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- 2.08.02 Density of Material shall be between 40 to 60 Kg/m³
- 2.08.03 Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m²K at an average temperature of 0°C
- 2.08.04 The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
- 2.08.05 Material should be FM (Factory Mutual), USA approved.
- 2.08.06 Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.
- 2.08.07 Under-deck insulation thickness shall be as per HVAC requirement and calculation.
- 2.08.08 Under-deck insulation shall be provided for all AC areas having roof/floor exposed to sun/hot environment.

2.09.00 Roof water proofing

- 2.09.01 Roof water proofing treatment shall be as follows:

After curing of the concrete, the roofs of building shall be provided with 3 layers, first being minimum 1.5mm thick elastomeric membrane waterproofing treatment coating with $\geq 500\%$ elongation confirming to ASTM C836 applied by a spray/brush/roller in two coats, secondly 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating over which screed concrete (of M20 with 12mm blue metal chips) shall be laid and finally the wearing course. 1.5mm thick Elastomeric membrane shall be laid as per manufacturer's specification. Run off gradient shall be given a minimum of 1 in 100. Gradient shall comprise screed concrete M20 using 12.5 mm or below coarse aggregate and waterproofing treatment as per IS:2645, mixed with polypropylene fibres. Over the screed concrete wearing course treatment shall be provided as below:

A wearing course shall consist of pressed clay tiles of size 230x230x18 mm minimum laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.





2.09.02 For vertical surfaces (Parapet)

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls (2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: *Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person.*

3.00.00 ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

4.00.00 I.S. CODES AND STANDARDS

- a) IS:73 : Paving Bitumen
- b) IS:702 : Industrial Bitumen
- c) IS:1203 : Methods of testing tar and bitumen
- d) IS:1322 : Bitumen felts for waterproofing and damp proofing
- e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts
- f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.
- g) IS:2645 : Specification for integral water proofing compounds for cement mortar and concrete.
- h) IS:3144 : Methods of test for mineral wool thermal insulation materials.
- i) IS:4641 : Expanded polystyrene for thermal insulation purpose.





Tender Specification
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VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: XIII

**GUIDELINE
FOR
WATER SUPPLY**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: XIII
Water Supply



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	5
3.00.00	TESTING AND ACCEPTANCE	9
4.00.00	I. S. CODES	9



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: XIII
Water Supply**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: XIII

**GUIDELINE
FOR
WATER SUPPLY**

1.00.00 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for industrial buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

General Requirements

Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the Bidder, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the Bidder. All water supply installation work shall be carried out through licensed plumber.

It is most important to ensure that wholesome water supply provided for drinking and culinary purpose is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be constructed a permissible substitute for complete absence of cross-connection.

Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only in to a cistern, and by a pipe or fitting discharging in to the air gap at a height above the top edge of the cistern equal to twice its normal bore, and in no case less than 15 cm.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such that can cause undue deterioration of the pipe.





Where the laying of any pipe through fouled soil or previous material is unavailable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non-return valves shall not be relied upon to prevent such back flow.

All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water damage to property and the risk of contamination of the water conveyed.

In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

Change in diameter and direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

Where the service pipe is of diameter less than 50mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.



Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not under ground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or claps shall be insulated from the piping by suitable pads.

The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joints.

Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cistern which shall have supply from storage tank.

No service or supply pipe shall be connected directly to any hot water system or to any apparatus used for heating other than through a feed cistern thereof.



1.01.00 Materials

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Bidder shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Bidder to procure the materials selected by the Engineer. Hence order is to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 Pipes and Pipe Fittings

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types:

- a) DI pipes
- b) P. V. C. Fittings/fixtures
- c) Copper fittings
- d) Brass fittings
- e) Galvanized Iron- heavy & medium duty pipes- is 1239 & is 4736

However for water supply in buildings only GI pipes of Medium class as per IS 1239 shall be used. And all the pipes shall be laid inside the buildings in concealed type

1.03.00 Water Tanks

Water tanks shall be made of HDPE, shall be factory made and from reputed brand with proper test certificates. The capacity of tanks shall be as per drawing design or as per instruction of Engineer-in-Charge.

1.04.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply





systems shall come under scope of the Bidder unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 Regulation

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Bidder).

2.00.00 INSTALLATION

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Bidder for approval of the Engineer.

Special attention shall be given by the Bidder to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 Pipe Lines

2.01.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 Contamination

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.





No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Pippings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Bidder may co-ordinate with the building Bidder for leaving the chases, openings, conduits as necessary. However, the Bidder will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leak proof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

a) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

b) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing





compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

2.01.07 Painting

Where mentioned, underground steel pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I./MS/DI. pipes shall be given a coat of zinc ethyl silicate primer, And finish coats as specified elsewhere in this SPEC.

Polythene Water Storage Tanks

Material

Polythene used for manufacture of tanks and manhole lids may be high density (HDPE,) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminated the water nor impart any test, colour, odour or toxicity to water.

Manufacture and Finish

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

Shape, Size and Capacity

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a clearance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank or up to the bottom of the inlet location whichever is less. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

Weight and Wall Thickness

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon



the capacity and the location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter in to the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

Sl. No.	Capacity (litres)	Minimum Wall Thickness (mm)	Minimum Weight of Empty Tank (kg)
1	2	3	4
1.	200	4.4	7.8
2.	300	4.4	9.0
3.	400	5.5	15.0
4.	500	6.0	18.0
5.	700	7.0	23.5
6.	1000	6.6	33.0
7.	1250	7.0	40.0
8.	1500	7.0	47.0
9.	1700	7.0	54.0
10.	2000	7.0	64.0
11.	2500	8.2	81.0
12.	3000	8.2	96.0
13.	4000	8.8	138.0
14.	5000	10.4	191.0
15.	6000	10.7	209.0
16.	7500	10.7	250.0
17.	10000	11.5	363.0
18.	15000	11.5	550.0
19.	20000	13.2	814.0

2.02.00

Valve, Cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned elsewhere in the specification.. Nominal size and material shall be as Specified.

Protection



Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains after Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.00.00 I.S.CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065 : Code for Practice for water supply in buildings

IS:1172 : Code of basic requirements for water supply, drainage and sanitation





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polyethylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks
IS:4736- 1986	:	Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

**VOLUME: II-B
SECTION: I

PART: C

SUB SECTION: XIV

GUIDELINE
FOR
DRAINAGE AND SANITATION**



Development Consultants Pvt. Ltd.

Volume: II-B
Section: I; Part C; Sub Section: XIV
Drainage and Sanitation



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	INSTALLATION	1
3.00.00	TESTING AND ACCEPTANCE	9
4.00.00	I. S. CODES	11



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: XIV
Drainage and Sanitation**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: XIV

**GUIDELINE
FOR
DRAINAGE AND SANITATION**

1.00.00 SCOPE

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a plant sewer or treatment work.

2.00.00 INSTALLATION

2.00.01 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 Rainwater Down comers & Soil and Drainage Pipes

Rainwater down-comers shall be standard, DI Pipes.

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.





Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.01.01 **Unplasticized Polyvinyl Chloride (UPVC) Pipes (for sanitary lines above GL)**

The specification covers requirements for plain and socket end unplasticised polyvinyl chloride (UPVC) pipes with nominal outside diameters 40 mm to 160 mm for use for soil and waste discharge system inside buildings including ventilating and rain water applications. In this specification nominal outside diameter DN of pipes are 40, 50, 63, 75, 90, 110, 125, 140 and 160 mm.

Surface colour of the pipes shall be dark shade of grey. For other details and specifications refer code IS: 13592-1992 (amended to 1995)

Above quality of pipes are divided into two types. Type –A (IS 13592) meant for rain water pipes & Type- B meant for soil pipes.

The water supply pipes for the building shall be of CPVC.

Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

Marking

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meters.

- a) Manufacturer's name or trade mark.
- b) Nominal outside dia of pipe.
- c) Type 'A'
- d) Batch number.

Dimensions

Diameter and Wall Thickness : Mean outside diameter, outside diameter at any point and wall thickness for type-A or type-B manufactured plain or with socket shall be as given in Table-1 of IS 13592.

Fixing and Jointing

Pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x50x50 mm hard wood plugs, screwed with M.S. screws of required length i/e cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of



wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

Installation in Wall/ Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted in to the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation.

Fittings

Fittings used shall be of the same make as that of the PVC pipes injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 302 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

2.01.03

Pipes-Galvanised Iron

The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HIRW or HFW screwed and socketted conforming to the requirements to IS 1239 Part – I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

Galvanising shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be clearly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be cleaned and well cut. The ends shall be cut clearly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

All tubes shall withstand a test pressure of 50 kg/sq.cm without showing defects of any kind.

Fittings : The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.



2.02.00

Gutters

The gutters shall be made of G.I. or as specified elsewhere in the contract. All gutters shall be supplied by reputable specialized firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.01

Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

2.03.02

Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03

Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04

Support and Protection on Pipelines





All pipes shall be laid with sockets leading uphill. For on/above ground level, Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. For underground PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

For above ground level the pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.03.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown



on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 Manhole and Inspection Chambers

All manholes and inspection chambers shall be in RCC. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgment for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer.

2.04.01 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.



Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Bidders from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00

Fixtures

The successful bidder shall furnish the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Bidder shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01

Water closet





a) **Raised type**

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) **Squatting type**

It shall include glazed vitreous china pan with foot rests and high level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, PVC/ glazed stoneware automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once in every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated. Sensor based urinals shall be provided at important areas as decided by the Engineer in charge

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated. The washbasins preferably oval shaped fitted on Granite Top.

2.05.04 **Sink**

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**





Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 Liquid soap dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 Installation

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Bidder.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test





All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and



- ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

- IS: 1172 - Code of basic requirements for water supply drainage and sanitation.
- IS: 1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.
- IS: 1239 - Mild Steel Tubes and Mild Steel Tubular and other (Pt.I & II) wrought steel pipe fittings.
- IS: 1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
- IS: 1537 - Vertically cast iron pressure pipe for water, gas & sewage.
- IS: 3486 - Cast Iron spigot & socket drain pipes.
- IS: 1742 - Code of Practice for building drainage.
- IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings.
- IS: 2470 - Code of Practice for designs and construction of septic tank for small and large installations.
- IS: 3076 - Low density polythelene pipes for potable water supplies.
- IS: 4984 - High density polythelene pipes for potable water supplies.
- IS: 1537 - Vertically cast iron pressure pipes for water, gas and sewage.
- IS: 1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.
- IS: 1230 - Cast Iron rain water pipes and fittings.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- IS: 3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.
- IS: 1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.
- IS: 1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).
- IS: 458 - Concrete pipes (with and without reinforcement)
- IS: 783 - Code of Practice for laying of concrete pipes.
- IS: 784 - Prestressed concrete pipes.
- IS: 651 - Salt glazed stoneware pipes & fittings.
- IS: 4127 - Code of practice for laying of glazed stoneware pipes.
- IS: 1726 - Cast Iron manhole covers and frames intended for use in drainage works.
- IS: 5961 - Cast Iron gratings for drainage purposes.
- IS: 5219 - 'P' & 'S' traps.
(Part 1)
- IS: 771 - Glazed earthen-ware sanitary appliance.
- IS: 772 - General requirements of enamelled cast iron sanitary appliances.
- IS: 774 - Flushing cistern for water closets & urinals (valve less siphonic type).
- IS: 775 - Cast Iron brackets & supports for wash basins and sinks.
- IS: 2548 - Plastic water closet seats & covers.
- IS: 2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.
- IS: 1703 - Water fittings- copper alloy float valves (horizontal plunger type)
- Specification.
- IS: 1795 - Specification for pillar taps for water supply purpose.
- IS: 2556 (Part-1, Part-2, Part-3, Part-4, Part-5, Part-6, Part-7, Part-14, and Part-15)
 - Part-1: General requirements
 - Part-2: Specific requirements of wash-down water closets.
 - Part-3: Specific squatting pans.
 - Part-4: Specific requirements of wash basins.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- Part-5: Specific requirements of laboratory sinks.
 - Part-6: Specific requirements of Urinal & Partition plates.
 - Part-7: Specific requirements of accessories for sanitary
 - Part-14: Specific requirements of integrated squatting pans.
 - Part-15: Specific requirements of universal water closets.
-
IS: 3989	-	Specification for centrifugally cast (9spun) iron spigot and Socket soil, waste and ventilating pipes fittings and accessories.
IS: 4827	-	Specification for electroplated coating of nickel and chromium on copper and copper alloys.
IS: 4985	-	Unplasticised P.V.C pipes for potable water supply- Specifications.
IS: 4127	-	Code of Practice for Laying of Glazed Stone Ware Pipes.
IS: 4885	-	Specifications for Sewer Bricks.
IS: 12592	-	Pre-cast Concrete Manhole Covers and Frames – Specifications.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION: I

PART: C

SUB SECTION: XV

**GUIDELINE
FOR
FLY ASH BRICKS**



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: XV
Fly Ash Blocks / Bricks**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	1
2.00.00	CODES & STANDARDS	1
3.00.00	GENERAL REQUIREMENTS	2
4.00.00	CLASSIFICATION	2
5.00.00	DIMENSIONS AND TOLERANCES	2
6.00.00	MATERIALS	2
7.00.00	PHYSICAL CHARACTERISTICS	4
8.00.00	SAMPLING AND CRITERIA FOR CONFORMITY	4
9.00.00	MARKING	4



Development Consultants Pvt. Ltd.

**Volume: II-B
Section: I; Part C; Sub Section: XV
Fly Ash Blocks / Bricks**



**VOLUME: II-B
SECTION: I**

PART: C

SUB SECTION: XV

**GUIDELINE
FOR
FLY ASH BRICKS**

1.00.00 SCOPE

This document lays down the specific technical requirements regarding classification, general quality, dimensions and physical requirements of pulverized fuel ash – Cement Bricks which may be used as per instruction of Engineer-in-charge.

2.00.00 CODES & STANDARDS

The following Indian Standards contain provisions which, through reference in this text, constitute provision of this document.

IS 12894: 2002	:	Pulverized Fuel Ash-Lime bricks - Specification
IS 712: 1984	:	Specification for building limes
IS 1727: 1967	:	Methods of test for pozzolanic materials
IS-269-1989	:	Ordinary Portland cement 33 grade specification
IS-8112-1989	:	Ordinary Portland cement 33 grade specification
IS-12269-1987	:	Ordinary Portland cement 53 grade specification
IS: 3812-2003(PART1)	:	Pulverized fuel ash specifications for use of pozzolona in cement, cement mortar and concrete
IS-3812-2003(PART 2)	:	Pulverized fuel ash specifications for use as admixture in cement mortar and concrete
IS 3495(Part1): 1992	:	Determination of compressive strength of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of water absorption of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of efflorescence of burnt clay building bricks
IS 3812: 1981	:	Specification for fly ash for use as pozzolana and admixture





IS 4139: 1989 : Specification for calcium silicate bricks
IS 5454: 1978 : Methods for sampling of clay burnt building bricks

3.00.00 GENERAL REQUIREMENTS

Visually the bricks shall be sound, compact and uniform in shape. These shall be free from visible cracks, warpage and organic matters. The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in shape, texture and colour. When broken they shall leave no lumps or grit.

4.00.00 CLASSIFICATION

Pulverized fuel ash-cement bricks shall be classified on the basis of average wet compressive strength as given below:-

Table 1

Class Designation	Average wet compressive strength not less than
10	100 kgf/cm ²
7.5	75 kgf/cm ²
5	50 kgf/cm ²

5.00.00 DIMENSIONS AND TOLERANCES

5.01.00 Dimensions

The Dimension of Fly ash bricks shall be 230X110X75

5.02.00 Tolerances

The dimensional tolerance of bricks shall be as outlined in Cl. 5.2 of IS 12894: 2002 and IS 2185: 1979

6.00.00 MATERIALS

6.01.00 Pulverized Fuel Ash (Commonly known as Fly Ash)

Pulverized fuel ash commonly known as fly ash collected from ESP shall conform to Grade 1 or Grade 2 of IS 3812.





6.02.00 Sand/Stone Dust/Aggregates

Contractor shall use available sand/stone dust which is used for concrete work. The following practice generally followed:

Deleterious materials, such as clay and silt in sand/stone dust shall preferably be less than 5 percent as per IS 12894:1990. Field test with the help of measuring cylinder to ascertain percentage of deleterious materials should be carried for every truck load of sand/stone dust.

6.03.00 Cement

Cement used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS 8112:1989 for 43 grades and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

6.04.00 Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

6.00.00 Proportioning of Raw Materials

Fly ash: 50-60%
Sand/stone dust: 30-40%
Cement: 8 to 10%

The strength of the bricks manufactured with above proportion shall be at least of 7.5 N/sqmm after 28 days.

Mix proportions stated above can be utilized as guide lines. Based on the quality of raw materials, the exact mix proportion may be finalized by trial mixes to produce good quality bricks of required compressive strength. The above proportions are tentative and shall be revalidated by getting tested at approved lab. The contractor shall seek approval from the owner before carrying out mass manufacturing. Owner shall check the quantities as and when he deems fit. In any case if a source of any raw material is changed, owner's approval to taken and manufactured bricks shall be tested.



7.00.00 PHYSICAL CHARACTERISTICS

7.01.00 Compressive Strength

The minimum average wet compressive strength of pulverized fuel ash-cement bricks shall not be less than the one specified in Table 1 (shall satisfy minimum class 5) when tested as described in IS 3495 (Part 1). The wet compressive strength of any individual brick shall not fall below the minimum average wet compressive strength specified for the corresponding class of bricks by more than 20 percent.

7.02.00 Drying Shrinkage

The average drying shrinkage of the bricks when tested by the method described in IS 4139, being the average of three units shall not exceed 0.15 percent.

7.03.00 Efflorescence Test

The bricks when tested in accordance with the procedure laid down in IS 3495 (Part 3) shall have the rating of efflorescence not more than "moderate".

7.04.00 Water Absorption

The bricks when tested in accordance with the procedure laid down in IS 3495 (Part 2), after immersion in cold water for 24 hours, shall have average water absorption not more than 20 percent by mass.

8.00.00 SAMPLING AND CRITERIA FOR CONFORMITY

Sampling and criteria for conformity of the bricks shall be as given in IS 5454.

9.00.00 MARKING

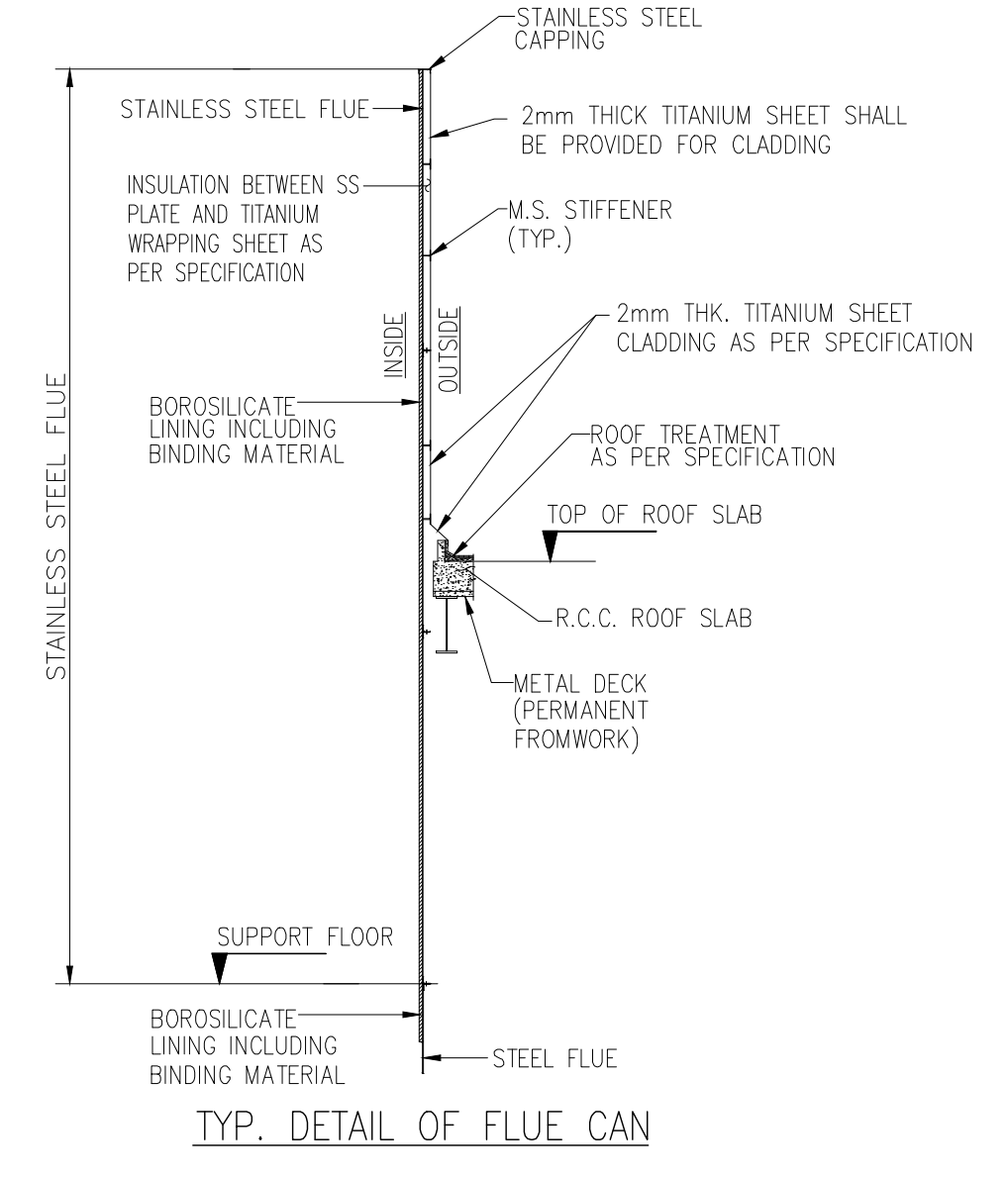
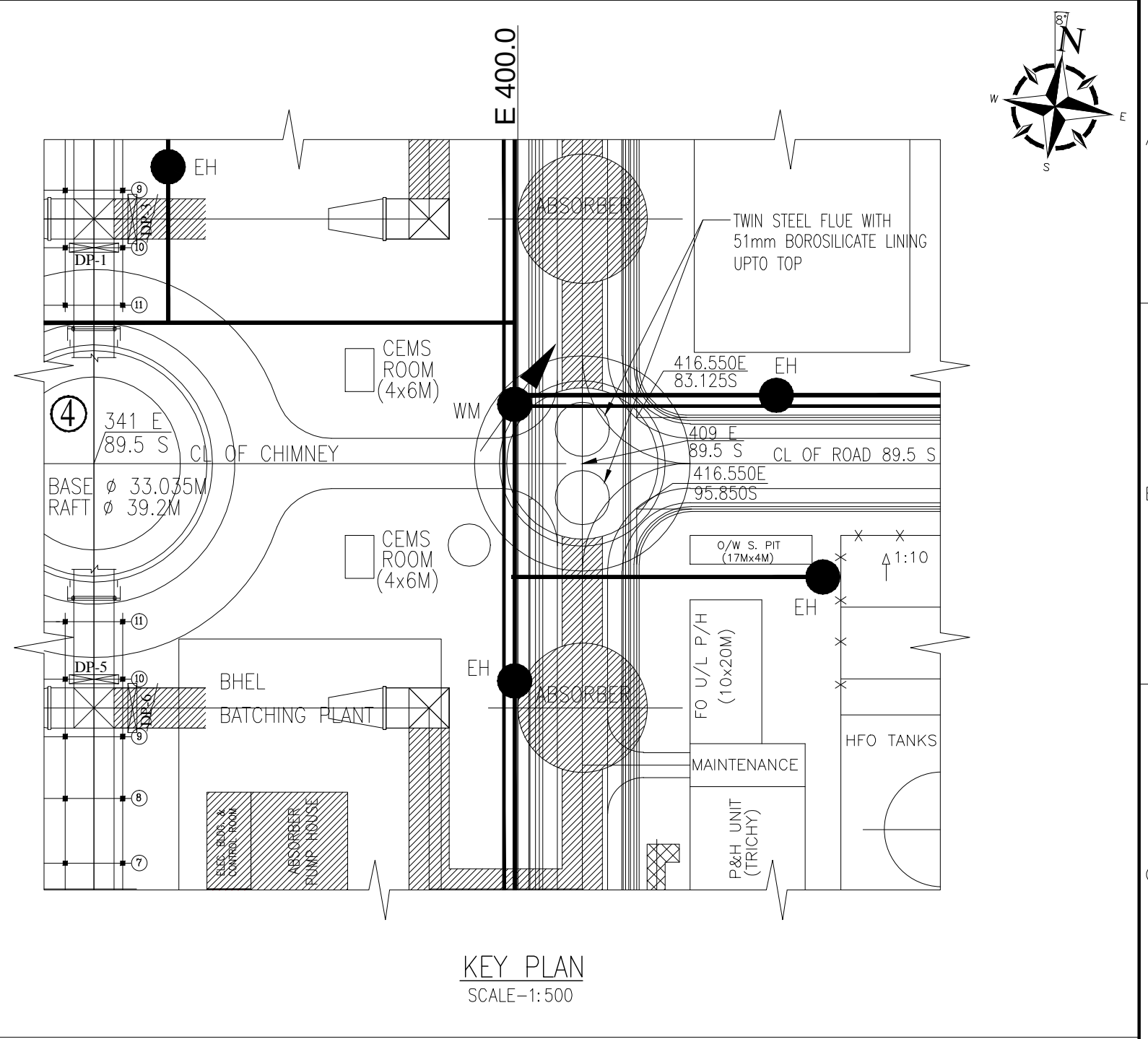
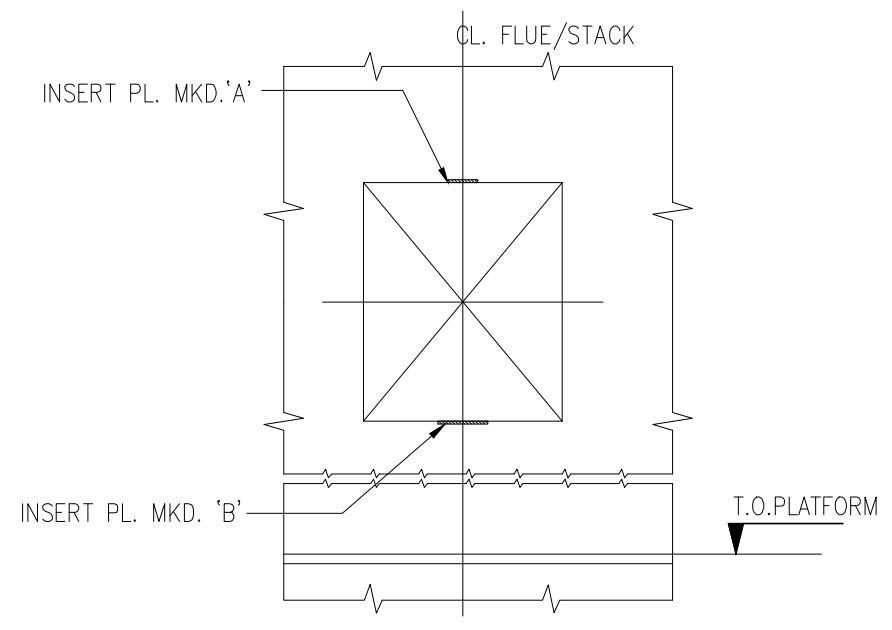
Each brick shall be marked in a suitable manner with the manufacturer's identification mark or initials.

FILE LOCATION: D:\Autocad Drawings\DCPL LOCK DOWN TIME\18A09(NTPL)\WORKING DWG\18A09-DWG-C-0001-RO-23-06-20.dwg
PLOT DATE: 6/23/2020 6:46:36 PM

THIS DRAWING IS FOR TENDER PURPOSE ONLY. ACTUAL SIZE, ARRANGEMENT, FOUNDATION SYSTEM, THICKNESS, DIMENSIONS, ELEVATION ETC. SHALL BE DETERMINED AND FINALIZED DURING DETAIL ENGINEERING STAGE.

- OPENING FOR THE FOLLOWING PORTS TO BE PROVIDED ON SHELL OF CHIMNEY:
- 1) HF ANALYZER
 - 2) MERCURY ANALYZER
 - 3) OXYGEN ANALYZER
 - 4) FLUE GAS FLOW MEASUREMENT
 - 5) SO₂/NO_x/CO/CO₂ ANALYZER
 - 6) FLUE GAS TEMPERATURE MEASUREMENT
 - 7) OPACITY MONITOR
 - 8) MANUAL SAMPLING

NOTE:-
LOCATION OF TEST PORTS AND SAMPLING POINTS SHALL BE STRICTLY AS PER LATEST CPCB / TNPCB NORMS & REGULATIONS.



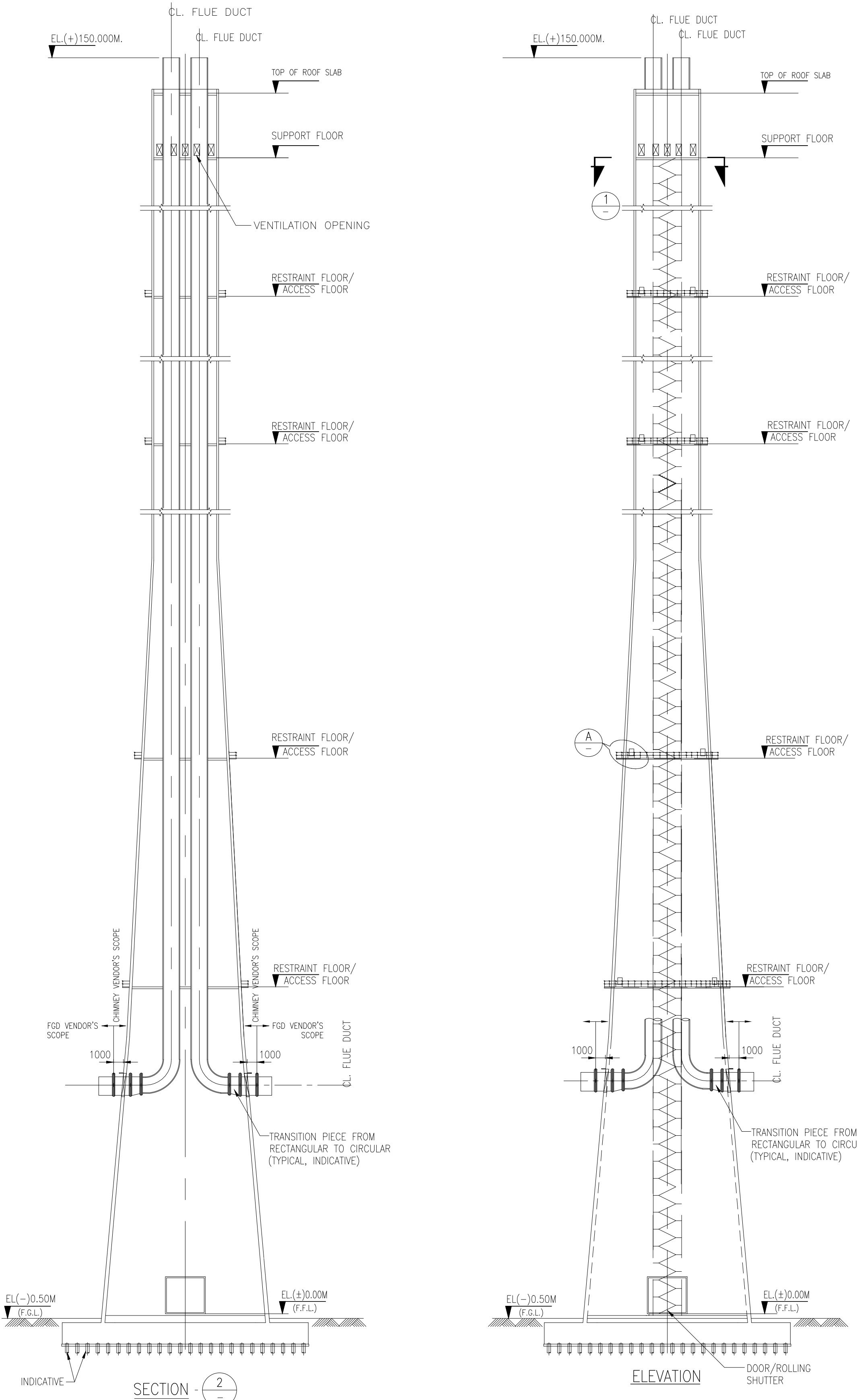
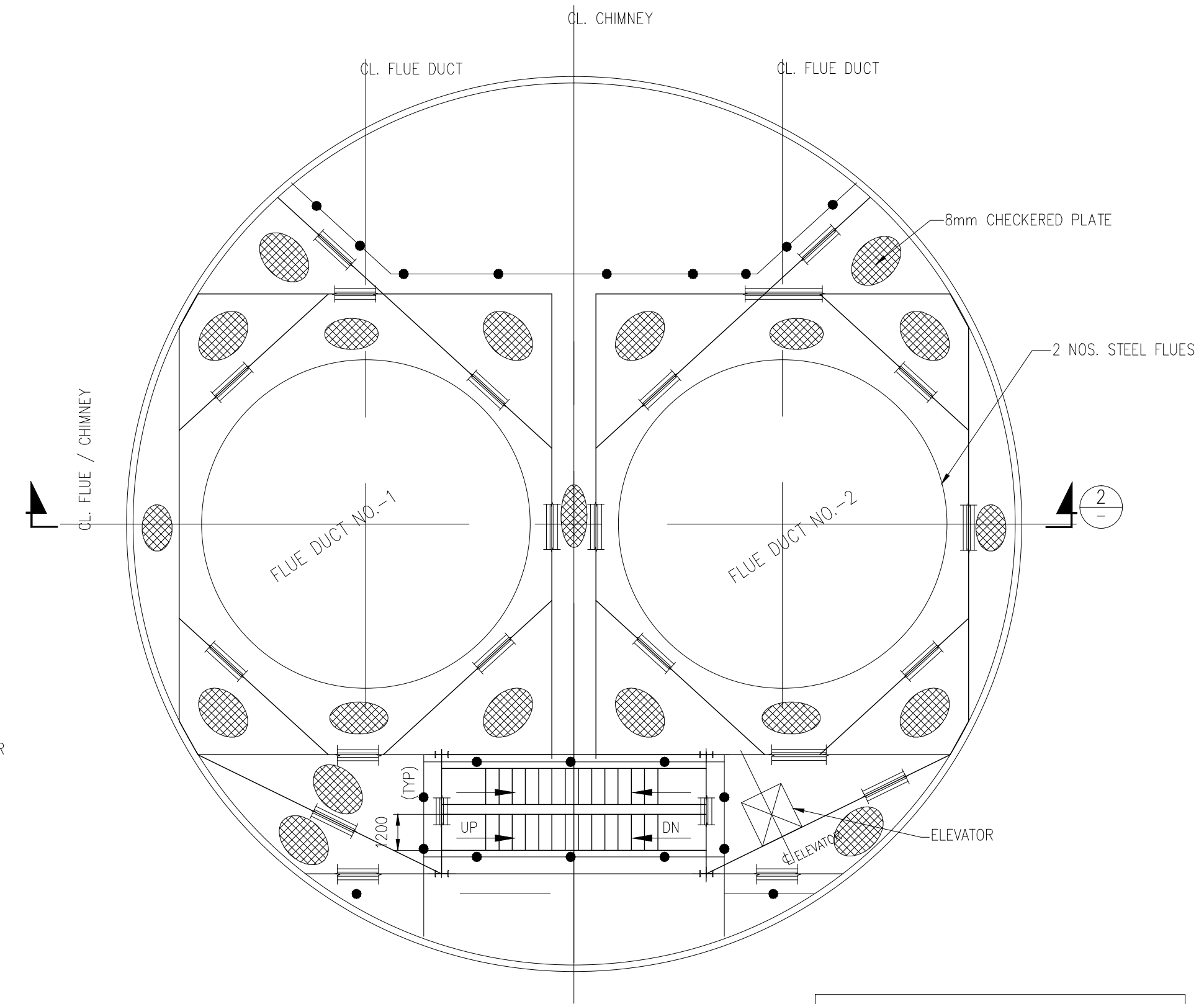
- NOTES:-
1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METER UNLESS OTHERWISE NOTED.
 2. DIAMETER OF STEEL FLUE WILL BE FINALISED DURING DETAIL ENGINEERING STAGE BY THE BIDDER.
 3. STACK ELEVATOR SHALL BE SUPPLIED ALONG WITH THE CHIMNEY.
 4. ACCESS FLOOR LEVELS WILL BE FINALISED DURING DETAIL ENGINEERING.
 5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CHIMNEY SPECIFICATIONS.

FOR TENDER PURPOSE ONLY

	OWNER:	NLC TAMILNADU POWER LIMITED		
	PROJECT:	2x500 MW THERMAL POWER PLANT AT TUTICORIN		
	TITLE:	GENERAL ARRANGEMENT OF 150M HIGH BI-FLUE CHIMNEY		
	DEVELOPMENT CONSULTANTS PVT LTD. CONSULTING ENGINEERS KOLKATA • MUMBAI • CHENNAI • NEW DELHI			
	PREPARED CHECKED APPROVED	ASHIS/PS NC AR	JOB NO. SCALE DATE	18A09 AS NOTED 23.06.20
DWG. NO.		18A09-DWG-C-0001		REV 0 1 OF 1

APPROV.	MECH.	INST.	ELEC.	STRL.	ARCH.	NATURE OF REVISION & DESCRIPTION	CHECKED	DRAWN	REV.	DATE

NOTE:-
MINIMUM FOUR (4) NUMBER OF EXTERNAL PLATFORM SHALL BE PROVIDED AS PER SPECIFICATION

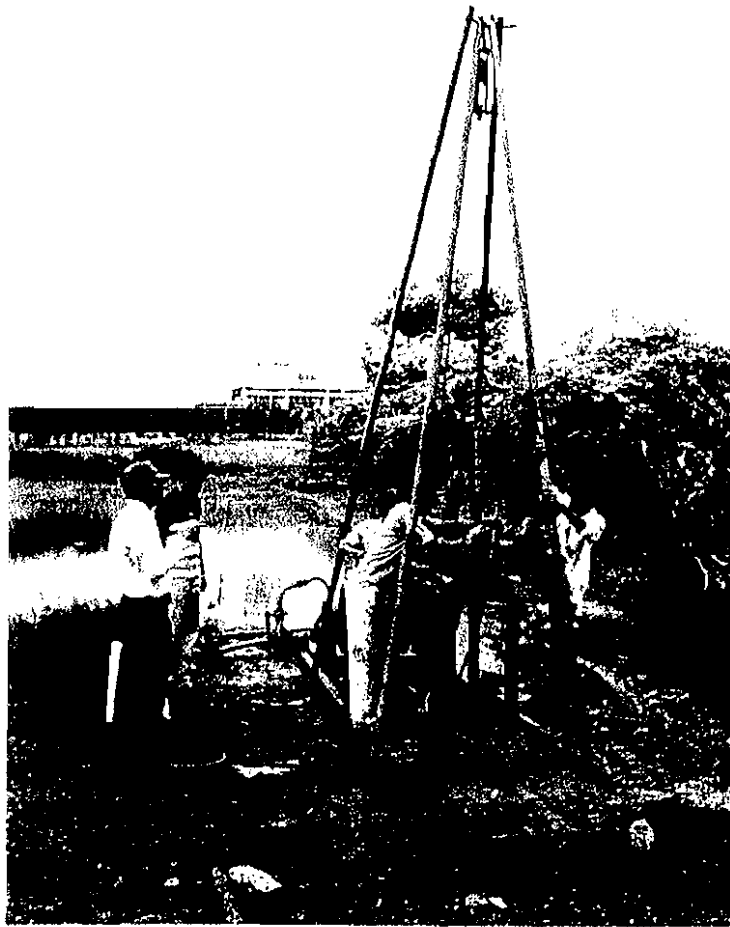


A REPORT ON SOIL INVESTIGATION FOR PROPOSED 2 X 500 MW NLC THERMAL POWER STATION AT TUTICORIN

Client:

NEYVELI LIGNITE CORPORATION

VOLUME-I



Prepared By:

Geostruct Engineering & Testing Services

8-sahajanand co-op industrial estate

Munjmahuda Baroda-390021

Ph (0265) 2341590 Fax: (0265) 2358415

Email: geostruct_engg@yahoo.com

Submitted: June - 2005

SUBSURFACE INVESTIGATION FOR PROPOSED 2 X 500 MW
THERMAL POWER STATION AT TUTICORIN

VOLUME-1

INDEX

Sr. No.	DESCRIPTION	PAGE
1	INTRODUCTION	1
2	FIELD WORK	1
3	LABORATORY TESTS	14
4	SUB SOIL STRATIFICATION	22
5	DISCUSSION ON FIELD AND LAB TEST RESULTS	22
6	SOIL BEARING CAPACITY	33
7	RECOMMENDATIONS	38



ISO 9001 : 2000
Reg. No. : R91/1462

GETS/2005/811

GEOSTRUCT

ENGINEERING & TESTING SERVICES

8 Sahajanand Indul. Estate, Munjmahuda,
Padra Road, Vadodara - 390020,
Phone : 0265-2341590
Fax : 0265-2358415
Email : geostruct_engg@yahoo.com

24.08.2005

SOIL INVESTIGATION FOR PROPOSED 2 x 500 MW NLC THERMAL POWER PROJECT AT TUTICORIN, TAMIL NADU.

1.0 INTRODUCTION

M/s Neyveli Lignite Corporation Ltd has proposed to put up 2 x 500 M.W Thermal Power Station at Tuticorin in the Port Trust area. The work of conducting subsurface investigation was awarded to M/s Geostruct Engineering & Testing Services Baroda Vide Letter of Intent Lr. No. TM/IV/T.No.64/2004/CGM/C/2005 Dated 18.02.2005.

The object of the sub soil exploration was (i) To determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table, Static and dynamic properties of soil (ii) To suggest suitable type of foundation along with load bearing capacity.

The Power plant is proposed to be located at Tuticorin Port Trust area near the existing Toothukudi Thermal Power station of TNEB.

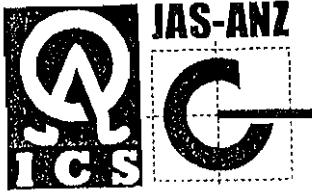
This report is in two volumes

Volume -1 covers description of tests carried out, recommendation of safe bearing capacity for different of foundations.

Volume -2 covers borelogs, trialpit logs, stratification sections, graphs and tables.

2.0 FIELD WORK

The actual investigation work was started on 17-04-2005 and was completed on 30.05.2005.



ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

2.1 Boreholes and Trial Pits

Twenty boreholes of 150mm diameter were drilled through the soil up to 5.0m depth in rocky strata. The depth of boreholes varied from 8.5m to 20.0m below existing ground level depending upon the depth at which rock was encountered. The work was in general accordance with IS: 1892 – 1979. The boreholes were located as shown in the location plan attached as Plate - 1. Plate 2 to 21 shows the bore logs detail.

Ten trial pits (3m x 3m) are excavated for visual observation of substrata up to depth of 3.0m. Unconfined compression test were conducted using pocket penetrometer in the field and disturbed / undisturbed samples are collected from each trial pit for laboratory testing (Plate 22 to 26).

2.1.1 Disturbed Samples

Disturbed representative samples were collected, logged, labelled and placed in polythene bags.

2.1.2 Undisturbed Samples

Undisturbed soil samples are collected in 70mm / 100 mm diameter thin walled sampler (Shelby tube) from the borehole. The sampler used for the sampling had smooth surface and appropriate area ratio and cutting edge angle thereby minimising disturbance of soil during sampling.

2.1.3 Water Samples

Water table encountered at a depth of about 0.18m to 0.70m below ground level during the sub soil exploration work carried out in the month of April - May 2005. Water samples were collected in 1 litre PVC cans from each borehole for chemical analysis.

2.1.4 Method of Sampling

Sampler was coupled together with a sampler head to form a sampling assembly. The sampler head provide a non-flexible connection between the sampling tube and the drill



ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

rods. Vent holes are provided in the sampler head to allow escape of water from the top of sampler tube during penetration. The sampling tubes were made free from dust and rust. Coating of oil was applied on both sides to obtain the undisturbed samples in best possible manner.

The sampler was then lowered inside the borehole on a string of rods and driven to a pre-determined level. On completion of driving the sampler is first rotated within the borehole to shear the soil sample at bottom and then pulled out. Upon removal of the sampling tubes, the length of sample in the tube was recorded. The disturbed material in the upper end of the tube, if any, was completely removed before sealing.

The soil at the lower end of the tube was trimmed to a distance of about 10 to 20 mm. After cleaning and inserting an impervious disc at each end, both ends were sealed. The empty space in the sampler, if any, was filled with the moist soil, and the ends covered with tight wrapper. The identification mark was then made on each sample.

2.2 Standard Penetration Test

The standard penetration tests were conducted in each bore as per IS: 2131: 1981 (Reaffirmed 1987). The split spoon sampler resting on the bottom of bore hole was allowed to sink under its own weight, then the split spoon sampler was seated 15 cm with the blows of hammer falling through 750mm. The driving assembly consists of a driving head and a 63.5 kg weight. It was ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides or between ropes. The rods to which the sampler was attached for driving were straight, tightly coupled and straight in alignment. Thereafter the split spoon sampler was further driven by 30cm. The number of blows required to drive each 15cm penetration was recorded. The first 15cm of drive considered as seating drive. The total blows required for the second and third 15cm penetration is termed as penetration resistance - N value. The N-values for each borehole are given in bore logs attached as Plate 2 to 21.

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

2.3 Static Cone Penetration Test

The test was performed as per IS: 4968 (part-3): 1976, Reaffirmed - 1987. The test procedure for determining the static cone and frictional resistances consists of pushing the cone alone through the soil strata to be tested, then the cone and the friction jacket, and finally the entire assembly in sequence and noting the respective resistance in the first two cases. The cone was pushed through a distance in accordance with the design of the equipment and the need for the substrata and the cone resistance noted. Thereafter, the cone and the friction jacket were pushed together for a distance depending upon the design of the cone and friction jacket assembly and the combined value of cone and friction resistance noted. This procedure was repeated continuously up to refusal (10 tonne capacity of equipment).

The equipment was securely anchored to the ground at the test point for obtaining the required reaction. The jack of the driving mechanism was brought to the top most position. The cone-friction jacket assembly was connected to the first sounding rod and the mantle tube. This assembly was positioned over the test point through the mantle tube guide and held vertically. The plunger of the driving mechanism was brought down so as to rest against the protruding sounding rod.

For obtaining the cone resistance, the sounding rod only was pushed. Switching the gear clutch to the slow position, the drive handle was operated at a steady rate of 1 cm/s, approximately so as to advance the cone only to a depth which is possible with the cone assembly available. During this pushing, the mean value of the resistance as indicated by the Bourdon gauges was noted ignoring erratic changes. For finding the combined cone and friction resistance of the soil, the sounding rod was pushed to the extent the cone has been pushed at the rate of 1 cm/s noting the mean resistance on the gauges, ignoring erratic changes. The procedure was repeated after pushing the combined cone friction jacket and mantle tube assembly to the next depth at which the cone and friction resistance values were required. Extension sounding rods and mantle tubes were added after every one metre of pushing as the test proceeds.

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

2.4 Plate Load Test

Plate load tests were performed in accordance to IS: 1888 - 1982 (Reaffirmed 1988). A pit at the test level, having width equal to five times the test plate, was excavated upto the test depth, which in our case was 0.5 to 0.6m since the test was to be carried out above watertable as per NLC specifications and subsequent letter. The pit was carefully levelled and cleaned and protected against disturbance or change in natural formation. The reaction was transferred by means of anchors away from the test pit. No support of reaction girder was located within the test pit. The test plate (450 mm x 450 mm) was placed on the level ground, so that the centre of plate coincides with the centre of reaction girder/beam. The hydraulic jack (Cap. 50T) was centrally placed over the test plate with the loading column in between the jack and reaction beam so as to transfer load to the test plate. A minimum seating pressure of 70 g/cm² was applied and removed before the starting of the load test.

The two supports of the reference rod was placed over the firm ground, fixed with two dial gauges resting at diametrically opposite ends of the plates. The dial gauges were so arranged that settlement was measured continuously without any resetting in-between.

The load on soil in cumulative equal increment was applied. The load was applied through hydraulic jack without impact, fluctuation or eccentricity. The settlement was observed for each increment of load at 1.0, 2.25, 4.0, 6.25, 9.0, 16.0, 25.0, and at hourly intervals or to a time when the rate of settlement gets reduced to a value of 0.02 mm/min. The next increment of load was then applied and the observations were recorded. The test was continued till; a settlement of 40mm had occurred.

2.5 Cyclic Plate Load Test

Cyclic plate load test was performed as per the procedure stated in IS: 5249 & IS: 1888 - 1982 (Reaffirmed 1988).

The load increment was applied through hydraulic jack without impact, fluctuation or eccentricity. The settlement was observed for each increment of load 1.0, 2.25, 4.0, 6.25, 9.0, 16.0, 25.0, and at hourly intervals or to a time when the rate of settlement gets reduced to a value of 0.02 mm/min. The load was then released to zero & rebound was recorded. Then next increment was applied, & again corresponding settlement & rebound recorded.

From the data obtained from cyclic plate load test the elastic rebound of plate corresponding to each intensity of loading was obtained & load versus elastic rebound curve was plotted. The Coefficient of elastic uniform compression C_u is then calculated using following relation.

$C_u = \frac{P}{S_e}$; Where P = Pressure intensity kg/cm^2 , S_e = Elastic rebound in cm, The Coefficient

obtained from the test is then corrected for 10 m^2 area of foundation. Barken (1962) suggested that the values of C_u for the area up to 10 m^2 can be extrapolated as

$$\frac{C_{u1}}{C_{u2}} = \sqrt{\frac{A_2}{A_1}}$$

2.5 Block Vibration Test

Block vibration test is conducted for determination of dynamic parameters of the soil for design of machine foundations. The following dynamic parameters of soil are determined using Block vibration test.

- Shear modulus (G)
- Elastic Modulus (E)
- Coefficient of Elastic Uniform Compression (C_u)
- Coefficient of Elastic Uniform Shear (C_τ)
- Coefficient of Non-Uniform Compression (C_ϕ)
- Coefficient of elastic non-uniform shear (C_ψ)
- Damping coefficient of soil (ϵ)

The block vibration test was conducted as per the procedure stated in I.S.5249: 1992. A test pit of size of 3.0m x 6.0m was dug up to 0.50m depth since water table at test location was at 0.6m depth and as per I.S. the test shall be carried out above watertable or

foundation depth whichever is higher. A plain cement concrete block of M-20 grade concrete of size 1.0m x 1.0m and 1.5 m high was casted with the foundation bolt for mounting the oscillator. The concrete block was cured for a period of 15 days before testing.

Test Setup: The forced vibration tests are carried out and the vibrations are generated with the help of Lazan type of mechanical oscillator, which can produce a sinusoidally varying force in vertical direction only with respect to time. The magnitude of the force depends upon the speed of the oscillator. For running the oscillator a speed controlled DC motor is used. The mechanical oscillator and the D.C. motor are mounted on the concrete block and suitable connection between the power supply, speed control unit, DC motor are made.

Vertical Vibration Test: the vertical vibration tests were carried out as per I.S.5249: 1992 (clause. 5.4.1). The acceleration pickup was fixed on the top of the block such that it senses vertical motion of the block. The mechanical oscillator was mounted on the top of the block such that it generates purely vertical sinusoidal vibrations and the line of action of vibration force passes through the centre of gravity of the block. After choosing a suitable value of angle of eccentricity of masses, the oscillator was made to run at constant frequency. The signals of the acceleration pickups are fed into vibration meter to measure the amplitude of the vibration. The frequency of the oscillator was increased in steps up to maximum frequency of exciter and signals were measured. The same procedure was repeated for various values of angle of setting of eccentricity mass. A graph of amplitude versus frequency is plotted for each excitation level to obtain the natural frequency of the soil and the foundation block.

The coefficient of uniform elastic compression is determined using following expression:

$$C_u = \frac{4 \pi f_{nz}^2 M}{A}$$
; Where f_{nz} = Natural frequency obtained from graph, M = Mass of block, exciter and motor; and A = Contact area of block with the soil.

From the value of C_u obtained for the test block of contact area of 1.0 sqm, the value of C_u for the foundation having contact area 10sqm can be obtained from equation.

$$Cu_1 = Cu \times \sqrt{1/10}$$

Determination of damping coefficient of Soil: In case of vertical vibration test the value of damping coefficient of soil (ε) can be determined using the relation as shown below:

$$\varepsilon = \frac{f_2 - f_1}{2 f_{nz}}$$

Where f_1 and f_2 are frequencies at which the amplitude is equal to $X_m / \sqrt{2}$

X_m = Maximum amplitude, f_{nz} = Natural frequency obtained from the graph

From the value of Coefficient of elastic uniform compression (C_u) the values of following coefficients can be determined using the relation given in clause no 8.1

- a) Coefficient of Elastic Uniform Compression (C_u)
- b) Coefficient of Elastic Uniform Shear (C_τ)
- c) Coefficient of Non-Uniform Compression (C_ϕ)
- d) Coefficient of elastic non-uniform shear (C_ψ)

$$C_u = 1.5 C_\tau$$

$$C_\phi = 3.46 C_\tau$$

$$C_\psi = 1.5 C_\tau$$

Wave Propagation Test: The wave propagation test was carried out as per I.S.5249:1992 clause: 7 for determination of the Shear Modulus and the Elastic Modulus of soil. The oscillator was mounted on the block such that it generates purely vertical sinusoidal vibrations and the line of action of the vibrating forces passes through the centre of gravity of the concrete block. The oscillator was set to work at constant frequency, which generates Rayleigh (Surface) waves. To measure the wavelength of this wave, one ray was drawn from the centre line of the block in the longitudinal direction. One of the geophones connected to the phase meter is fixed at a distance of 300 mm from the face of the block



ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

along the ray drawn, such that the sensing axis of the geophone is vertical. Another geophone connected to the phase meter was moved along the ray away from the block keeping the sensing axis of the geophone vertical and recording the phase difference and distances between the geophones until the phase difference of more than 90 degree was met. A curve was plotted between the phase angle and the distance between the geophones. From the curve, the distance 'S' between the geophones for a phase difference of 90° was determined. The same procedure was repeated for various eccentricities of eccentric masses of the oscillator. Using the following relation the Rayleighs Wave length can be calculated in cms.

$$\lambda/4 = S$$

As the Rayleighs wave velocity and the shear wave velocity are nearly equal for soils thus the shear wave velocity can be found using the relation

$$\text{Velocity of shear waves } V_s = \lambda f$$

Where λ = Wave length in cm, S = Distance between geophones having phase difference of 90°, f = Frequency of Vibration, V_s = Velocity of shear Waves.

The shear modulus and the elastic modulus can be determined using the relation:

$$\text{The shear Modulus (G)} = V_s^2 \times \rho$$

$$\text{The Elastic Modulus (E)} = 2 \times G (1 + \epsilon)$$

Where, ρ = Mass density of soil in $\text{Kg sec}^2 / \text{m}^4$

ϵ = Poisson's ratio of soil. Value assumed as 0.4

2.6 Cross-hole Test

The general principle of the cross-hole test is to establish the shear wave (S-wave) and compression wave (P-wave) velocities of the soil and rock layer at selected depths. The



ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/B11 dated 24.08.2005

waves are generated in an "impulse" borehole and are detected by the geophones in "receiver" borehole drilled at known distance from the impulse borehole.

Three number of bore holes were drilled in straight line at a spacing of 3m intervals. The source bore was inserted with casing of 100mm diameter while other two source holes, casing of 90mm was inserted as per the specifications of the instrument used. The tests were carried out at 3m interval upto 26m depth. The tests below 27m depth was not possible due to squeezing of source hole. For conducting the test, the hammer and geophone were lowered to the test depth. The cables were marked with 1 m depth interval to ensure that the geophone and the hammer are at the same depth. The hammer was secured in this elevation by inflating the rubber tubes provided at the side of the hammer using air pressure. Similarly the geophones were lowered in the receiving holes and secured at the same elevation as that of hammer in the same manner. The tests were started by pulling the strike rode up with the help of string and then allowing it to fall under its own weight. The signals were enhanced by stacking which were achieved by repeating the process. Striking at least five to ten times stacked the waves. The procedures were repeated at each test depth.

2.7 Field Permeability Test

The test was carried out as by constant head method as per the prosedure stated in I.S. 5529 1985. A hole of 100mm diameter was drilled up to test depth and casing is sunk by drilling and driving. The hole was then cleaned by means of scooping spoons and bailer. The hole was kept full of water while cleaning. The test was started by allowing clean water in the bore through metering system to maintain gravity flow at constant head. The flow is adjusted by the regulating valve to obtain steady water level in borehole. When the rate of flow becomes more or less constant, the rate of inflow was recorded.

$Permeability (k) = \left(\frac{Q}{5.5 \times r H} \right)$, Where k = coefficient of permeability, Q = constant rate of

flow into the hole, r = internal radius of casing, H = Differential head of water H (Gravity head) – Hf (Head loss due to friction). When k is measured in cm/s, Q in litre/min and H in

metre, above equation may be written as $Permeability (k) = C_1 \times \frac{Q}{H}$, where C_1 is constant and its value is 6.06×10^{-3} for 100mm diameter casing pipe.

2.8 Field Vane Shear Test :

The field vane shear test is for very soft purely clayey soils which get disturbed during sampling. Such type of purely clayey soft soil was not encountered during investigation hence this test was not conducted.

The summary of fieldwork carried out is given in Table - 1 here under:

Table: 1 Summary of Fieldwork

Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
BH-1	745W	528S	1.91	15.0	6	2	7	0.35
BH-2	778W	285S	2.29	12.0	7	-	5	0.46
BH-3	685W	664S	1.64	20.0	10	2	12	0.35
BH-4	592W	585S	2.05	14.0	7	2	6	0.49
BH-5	520W	421S	1.46	12.0	7	2	5	0.20
BH-6	517W	121S	1.76	12.0	6	2	5	1.10
BH-7	420W	657S	1.53	14.0	7	2	6	0.20
BH-8	360W	342S	1.92	14.0	6	2	6	0.34
BH-9	360W	482S	1.48	13.5	7	2	6	0.33
BH-10	325W	242S	1.96	8.5	7	-	2	0.71
BH-11	182W	500S	1.84	14.0	9	-	5	0.18
BH-12	50W	489S	2.11	14.0	8	1	5	0.22
BH-13	25E	342S	2.74	15.0	7	2	5	0.20

ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/B11 dated 24.08.2005

Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
BH-14	145E	589S	2.10	15.0	6	2	5	0.25
BH-15	350E	410S	2.77	15.0	8	-	5	0.40
BH-16	680E	353S	2.34	13.0	7	-	5	0.40
BH-17	725E	550S	2.45	15.0	7	2	5	0.21
BH-18	990E	435S	2.22	12.5	8	-	5	0.25
BH-19	1310E	360S	2.40	14.0	7	2	5	0.19
BH-20	1265E	595S	1.69	13.0	7	-	5	0.70
TP-1	875W	625S	1.18	---	---	3	---	0.75
TP-2	810W	150S	2.24	---	---	3	---	0.45
TP-3	530W	335S	2.13	---	---	3	---	0.45
TP-4	530W	675S	3.87	---	---	3	---	2.0
TP-5	225W	590S	2.23	---	---	3	---	0.2
TP-6	170W	360S	2.85	---	---	3	---	0.3
TP-7	330E	575S	2.52	---	---	3	---	0.3
TP-8	565E	325S	2.21	---	---	3	---	0.25
TP-9	585E	615S	1.89	---	---	3	---	0.20
TP-10	1495E	375S	2.25	---	---	3	---	0.60
SCPT-1	753W	678S	1.70	6.0	---	---	---	---
SCPT-2	660W	482S	1.81	5.6	---	---	---	---
SCPT-3	467W	492S	1.85	6.2	---	---	---	---
SCPT-4	260W	510S	2.62	6.0	---	---	---	---
SCPT-5	430E	410S	2.65	6.4	---	---	---	---

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
SCPT-6	370W	670S	1.60	6.6	---	---	---	---
SCPT-7	360W	495S	1.52	6.6	---	---	---	---
CPLT-1	670W	470S	1.74	0.50	---	1	---	0.6
PLT-1	750W	660S	1.56	0.50	---	1	---	0.5
PLT-2	530W	525S	1.86	0.50	---	1	---	0.5
PLT-3	15E	517S	2.31	0.60	---	1	---	0.6
PLT-4	885E	520S	1.99	0.60	---	1	---	0.65
BVT-1	675W	540S	1.91	0.50	---	1	---	0.6
BVT-2	440W	460S	1.82	0.50	---	1	---	0.7
CBHT-1	500W	430S	1.62	---	---	---	---	---
FPT-1	745W	530S	1.90	2.75	---	---	---	0.35
FPT-2	25E	340S	2.74	2.30	---	---	---	0.20
FPT-3	145E	592S	2.10	3.0	---	---	---	0.19
FPT-4	1310E	368S	2.40	2.25	---	---	---	0.25

BH- Borehole, TP – Trial pit, SCPT – Static cone penetration test, CPLT – Cyclic Plate Load test,

CBHT – Cross Bore Hole Test, BVT – Block vibration test, FPT – Field Permeability test.

ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

3.0 LABORATORY TEST

The laboratory tests on soil and rock samples were started immediately after the receipt of the same in the laboratory. Following laboratory tests are carried out to determine the physical and engineering properties of undisturbed and disturbed soil samples and rock samples.

1. Dry density and moisture content (IS 2720 part – 2 & 29)
2. Particle size analysis – (IS 2720 part – 4 1985)
3. Atterberg's limit - (IS 2720 part – 5 1985)
4. Specific gravity - (IS 2720 part – 3/sec2 1980)
5. Shear test - (IS 2720 part – 11 1986)
6. Consolidation test – (IS 2720 part – 15 1986)
7. Standard Proctor test – (IS 2720 part 7, 1980)
8. Chemical analysis of soil and water- (IS 2720 part –26 1986 & 27 1977)

All laboratory tests are carried out as per the respective Indian Standards.

3.1 Field Dry Density & Natural Moisture Content

The weight of undisturbed soil sample with sampler (Shelby tube) is determined after removing paraffin wax and loose soil. The total length of soil sample recovery was determined after deducting empty length from the total length of sampler. The volume of soil mass retained in sampler is thus determined from the known inside diameter of sampler and total length of soil mass. The soil mass was then removed and the average moisture content was determined by keeping the soil sample along with crucible in oven at 100-105 degree centigrade for 24 hours. The empty weight of the sampler was then found out. From the total weight of sampler with soil mass, the weight of empty sampler was deducted. The field density is then found out as

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

$$\text{Field density (bulk)} = \frac{\text{weight of soil mass}}{\text{volume of soil mass}}; \text{ and, Field dry density} = \frac{\text{Field bulk density}}{1 + w}$$

Where w is water content.

3.2 Particle Size Analysis

The sieve analysis is carried out in accordance with IS: 2720 (Pt.IV). The results are presented in the form of Grain size distribution curve.

Representative soil sample is obtained from the bulk soil sample collected or received from site by method of coning and quartering. Quantity of soil taken will be dependent on the maximum size of particle size present in the soil. Sieve analysis is conducted in two parts:

Soil fraction retained on 4.75mm ISS: Soil portion retained on 4.75 ISS is weighed. The sample is then separated into various fractions by sieving through the following sieves: 100, 75, 19 and 4.75 mm ISS

While sieving through each sieve, sieve is agitated so that sample rolls in irregular motion over the sieve, at no time the particles are pushed through; Care is also taken to see that no individual soil particles are broken, though particles adhering one another are rubbed by rubber pestle when required. Care is also taken not to over load the sieve beyond the permitted maximum load for respective sieve. The mass of the material retained on each sieve is recorded. The percentage of soil retained on each sieve is then calculated on the basis of the total mass of soil taken and from these results, the percentage passing through each sieve is calculated.

Soil fraction passing 4.75 ISS: The portion of the soil passing 4.75 mm ISS is oven dried at 105 to 110 c. The portion is coned & quartered to obtain required representative quantity of the material. The material is weighed and placed in tray/bucket filled with water for soaking and loosening the adhered cohesive materials. The soaked soil specimen is then washed on 75 micron IS Sieve until the water passing the sieve is almost clear. The material retained on 75 micron IS Sieve is then transferred in a tray, dried in oven.



ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Sieve analysis is then conducted on a nest of sieves (viz. 2 mm, 425 and 75 micron ISS) either by hand or by using mechanical sieve shaker. The fraction retained on each of the sieves is weighed separately and masses recorded. Cumulative mass of soil fraction retained on each sieve is then calculated. The weights are then converted into cumulative percentage retained and passing on the basis of the mass of the sample passing 4.75 ISS taken. The combined gradation on the basis of the total sample taken for analysis is finally calculated.

3.3 Atterberg's Limit

Liquid and plastic limits are determined by using procedure given in IS: 2720 (Pt-V). The results are given in result sheet. The weight of cone plus rod and plate is 148 gm. A soil sample weighing about 150gm from the thoroughly mixed portion of soil passing 425 micron was used for testing. The thoroughly wet soil paste is transferred to the cylindrical trough 150mm diameter and 50mm high of the cone penetrometer apparatus and levelled up to the top of trough. The penetrometer is adjusted such that the cone point just touches the surface of the soil paste in trough. The scale of the penetrometer is adjusted to zero and the vertical rod is released so that the cone is allowed to penetrate into the soil paste under its own weight. The penetration is noted after 30 sec. from the release of the cone. The reading is considered if the penetration reading is between 20mm and 30 mm. The moisture content of the soil paste corresponding to this is determined. The liquid limit of the soil which corresponds to the moisture content of a paste which would give 25 mm penetration of the cone is determined using formula:

$$W_{LL} = W_x + 0.01 (25 - W) (W_x + 15)$$

For determination of plastic limit, a soil sample weighing at least 20 gm from the soil sample passing 425micron IS sieve is thoroughly mixed with water such that it can be easily moulded with fingers. A ball is formed with about 8 to 10 gm of this soil & is rolled between the fingers and the glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter of 3mm throughout its length. The soil is then kneaded together to a uniform mass and rolled again. The process is continued until the thread crumbles.

The pieces of crumbled soil thread are collected and moisture content is determined and reported as plastic limit.

3.4 Specific Gravity

The specific gravity of soil solids is determined by a 50ml density bottle. The weight (W1) of the empty dry bottle is taken first. A sample of oven-dried soil about 10-20 g cooled in a desiccator, is put in the bottle, and weight (W2) of the bottle and the soil is taken. The bottle is then filled with distilled water gradually removing the entrapped air either by applying vacuum or by shaking the bottle. The weight (W3) of the bottle, soil and water (full up to the top) is then taken. Finally the bottle is emptied completely and thoroughly washed and clean water is filled to the top and the weight (W4) is taken.

$$\text{Specific Gravity (G)} = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$$

3.5 Shear Test

Triaxial (undrained) tests are carried out to determine the shear parameters. The shear tests are carried out in accordance with IS: 2720 (pt. X, XI, XII and XIII) on saturated samples. For unconsolidated undrained triaxial compression test, the undisturbed soil specimen having diameter 38 mm and height to diameter ratio 2 is prepared and placed on the pedestal of the triaxial cell. The cell is then assembled with the loading ram and then placed in the loading machine. The cell fluid is admitted to the cell and the pressure is raised to the desired value. An initial reading of the gauge measuring axial compression of the specimen is recorded. The test is then commenced and sufficient number of simultaneous readings of load and compression measuring gauge being taken. The test is continued until the maximum value of the stress has been passed or until an axial strain of 20 per cent has been reached. Additional tests are carried out on identical specimen at confining pressure of 1 kg/cm², 2 kg/cm² and 3 kg/cm². The shear parameters are obtained from the plot of Mohr circles.



ISO 9001 : 2000
Reg. No. : R91/I462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Direct shear test is carried out using shear box with the specimens (60mmx60mm). Specimen with plain grid plate at the bottom of the specimen and plain grid plate at the top of the specimen is fitted into position in the shear box housing and assembly placed on the load frame. The serrations of the grid plates are kept at right angle to the direction of shear. The loading pad is kept on the top grid plate. The required normal stress is applied and the rate of longitudinal displacement/shear stress application so adjusted that no drainage can occur in the sample during the test (1.25mm/min). The upper part of the shear box is raised such that a gap of about 1mm is left between the two parts of the box. The test is conducted by applying horizontal shear load to failure or to 20 percent longitudinal displacement whichever occurs first. The test is repeated on identical specimens.

3.6 Consolidation Test

The consolidation tests were carried out on undisturbed soil specimen in order to determine the settlement characteristics of soil at different depths. The tests were conducted in accordance to IS: 2720 (Pt-XV).

An undisturbed soil specimen is extruded to the consolidation ring of 60mm diameter. The edge is trimmed carefully such that the sample flushes with the top and bottom edges of the ring. The thickness of the specimen is measured and the weight is recorded. The bottom porous stone is then centred on the base of the consolidation cell.

The specimen is placed centrally between the bottom porous stone and the upper porous stone. A filter paper is provided in-between specimen and porous stones. Then the loading cap is placed on the top. The consolidometer is placed in position in the loading device and suitably adjusted. The dial gauge is then clamped into position for recording the relative movement between the base of the cell and the loading cap. A seating pressure of 0.05 kg/cm² is applied to the specimen. The cell is kept filled with water. After 24 hours the test is continued using a loading sequence on the soil specimen of 0.25, 0.5, 1.0, 2.0, 4.0, and 8.0 kg/cm². For each loading increment after application of load, readings of the dial

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

gauge is taken using time sequence 0, 0.25, 1, 2.25, 2, 6.25, 9, 16, 25, 36, 49 ... up to 24 hrs. From the observations of all incremental pressure, void ratio versus log (pressure) curve is obtained. The slope of the straight line portion is designated as compression index C_c .

3.7 Standard Proctor Test

The test is conducted in accordance to IS: 2720 (pt-7) 1980 to determine the moisture content relationship. A 5 kg air dried soil passing 20 mm IS sieve is taken and thoroughly mixed. The mould with base attached is weighed to the nearest 1 g. The soil is then moistened by adding 8 to 10 per cent water and compacted in to the mould in three equal layers. Each layer is being compacted by 25 blows of 2.6 kg rammer dropped from a height of 310 mm. The blows are distributed uniformly over the surface of each layer. The extension collar is removed, soil is trimmed and mould with base plate is then weighed to nearest 1 g. The compacted soil specimen is removed and moisture content is determined. The process is repeated by adding more water of about 2 per cent of dry soil till the density of sample decreases. The curve in-between dry density and moisture content is plotted and maximum dry density and corresponding optimum moisture content is reported.

3.8 Chemical Analysis

pH value, Sulphate and chloride contents of soil and ground water are determined.

pH Value (IS 2720 Pt.264 - 1987): A 30 gm of the soil passing 425 micron IS sieve is taken in a 100 ml beaker. 75 ml of distilled water is added to it and then stirred. The pH Value is then measured using pre-calibrated pH meter.

Sulphate: To determine soluble sulphate (IS 2720 Pt 27) 10gm of soil sample is placed in a 250 ml bottle allowed to stand overnight frequently stirred. Filter and 25 ml of filtrate in a beaker is taken and added concentrated hydraulic acid to just neutralize the solution if it is found alkaline. More acid is added to make the solution acidic. Solution is then boiled. Barium chloride solution is then added in the stream with constant stirring till there is no precipitation with further addition. Beaker is then placed on the steam bath for a

ISO 9001 : 2000
 Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

minimum period of 4 hour and precipitates are allowed to settle. Precipitates are then filtered through ash less filter paper, dry and ignited & Cooled in the desiccator, weighed and noted the weight of the residue. This is the weight of barium sulphate. A corresponding weight of sodium sulphate is calculated and its percentage is determined.

The chemical analysis of water is done as per IS 3025 - 1964.

Sulphate in the sample are precipitated by barium chloride and precipitate weighed as barium sulphate and reported as sulphate in mg/lit.

Chloride: The sample after neutralisation is titrated against standard silver nitrate solution using potassium chromate indicator. 100 ml of the sample is taken and 1 ml of potassium chromate indicator is added. It is then titrated against standard silver nitrate solution with constant stirring until there is perceptible reddish coloration. Chlorides (as Cl) is then calculated and reported in mg/lit.

The following laboratory tests are carried out on rocky samples and the tests are briefly described as below.

1. Classification of rock
2. Water absorption
3. Bulk density
4. Uniaxial compressive strength

All the laboratory tests are carried out as per relevant IS Codes. The procedure is briefly described as below :

3.1.1 Water Absorption

a) This method of test covers the procedure for determining the water absorption of rock sample in form of lumps of irregular shape-geometry and the rock which do not swell or disintegrate when immersed in water & oven dried.

- b) A representative sample comprising of least min. 10 lumps of irregular geometry each of about 50 g or a min. dimension of atleast 10 times the max. grain size, whichever is greater is selected. The sample is washed in water to remove loose particles. The sample is saturated in water immersion vessels & entrapped air is removed by gentle agitation.
- c) The vessels is then emptied & the sample is allowed to drain to become surface dried. The sample is then weighed (B). The sample is then dried in oven at 100 to 110 degree centigrade for not less than 24 hours. It is then cooled to room temperature & weighed (A). The water absorption is calculated from the following formula :

$$B - A$$

$$\text{Water absorption} = \frac{\text{-----}}{A} \times 100, \text{ percent}$$

$$A$$

3.1.2 Bulk Density of Rock sample

The procedure given for water absorption test in sub para (a) is followed :

- a) The saturated sample is then carefully introduced in a water displacement vessel to measure volume of sample. This vessel is siphon type. Water equal to the rock sample gets displaced by over flowing under siphon action and thereby volume of rock sample is determined. (V)

The bulk density is then determined by following formula.

$$\text{Bulk dry density} = w/v, \text{ g/cc}$$

Uniaxial Compressive Strength

This test is conducted on the core samples having length about 1.5 to 2.0 times the diameter of the sample on the universal compression-testing machine. For carrying out this test and analysis of the test provisions of IS: 9143: 1979 has been adopted.

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

4.0 SUB SOIL STRATIFICATION

Field and laboratory test data reveal in general that the sub soil strata are poorly graded fine silty sand up to about 5.0m to 6.0m depth. Below that there is a layer of weathered calcareous limestone having thickness of about 2.0m. Below that and up to the depth investigated, the calcareous lime stone is available. There is no much variation in sub strata, however there is a presence of about 1.0m to 3.0m thick clayey silt pocket nearby borehole BH-1 and BH-8 at about 3.0m to 4.0m depth from the existing ground level. Plate 27 to 28 shows the generalised cross sectional profile of the sub strata along North – South and East – West direction.

The rock core obtained from each borehole during drilling operation was examined and its detail geological description was given in the form of Table attached as Plate 29.

5.0 DISCUSSION ON FIELD AND LABORATORY TEST RESULTS

5.1 Field Test

5.1.1 Standard Penetration Test

A comparative study of observed N value (i.e. number of blows /30cm penetration) has been done for all the boreholes. The SPT N values for individual borehole are given in Plate 2 to 21. The depth wise SPT – N value (observed) in different boreholes is shown in Table 2. The SPT-N values (observed) are in the range of 5 to more than 50 in sandy stratum. This range values indicates loose to dense silty sandy stratum. From the SPT – N values variation it infers that the sub stratum up to about 1.0m depth and in between 4.0m to 5.0m depth is loose to medium in nature at many locations. The SPT – N value below 6.0m depth is further increases to more than 50 indicating dense sandy stratum in all the boreholes with few exceptional values. The SPT – N values in weathered rock shows more than 100 in all the boreholes. The SPT-N values variation in each borehole is shown in bore logs attached as Plate 2 to 21.

5.1.2 Static Cone Penetration Test (SCPT)

Seven SCPT were conducted at location shown in location map (Plate - 1). The tests are conducted up to 6.0m to 7.0m depth as per procedure shown above. The observation table along with graphs of depth versus cone penetration resistance (q_c) in kg/cm^2 are shown in Plate 30 to 36. The observed value is corrected and the average value of q_c at each location is determined between the level of the base of footing (assumed as 1.50m depth below existing GL) and the depth equal to 1.5 to 2 times the width of the footing (assumed as 1.0m). The weighted average of the q_c values is determined for each location and minimum of the average values is used for the further computation.

From plot of depth versus cone penetration resistance (Plate 30 to 36), it infers in general that the cone resistance value is very low in upper 1.0m depth and in between 4.0m to 6.0m depth in all the tests. The cone resistance value increases in between depth of about 1.0m to 4.0m. The weighted average cone penetration resistance within the average influence zone for shallow foundation (assumed as 1.50m to 4.0m depth below ground level) from the various tests are works out as shown in Table 3 below:

Table 3: Weighted Average Cone Resistance Value

Test	Weighted Average Cone resistance (kg/cm^2)
SCPT1	32.75
SCPT2	31.15
SCPT3	42.45
SCPT4	74.58
SCPT5	80.27
SCPT6	59.53
SCPT7	51.94

The minimum average cone resistance value is 31.15 kg/cm^2 , and therefore it is selected for further computation.

As per IS Code (IS: 6403), let $q_{ult-net} / q_c \approx 0.13$ (For $B = 1.0m$)

Therefore, $q_{ult-net} = 0.13 \times 31.15 = 4.0495 \text{ kg/cm}^2$.

$q_{net-safe} = q_{ult-net} / \text{FOS (3)} = 4.0495 / 3 = 1.349 \text{ kg/cm}^2$, say 13.49 t/m^2 .

Settlement can be computed using Meyerhof's approach as shown below:

$$q_{safe-pr} = 0.392 q_c \left(\frac{B + 0.3}{B} \right)^2 \text{ (For 25mm settlement).}$$

where $q_c \approx 31.15 \text{ kg/cm}^2$, and $B = \text{width of footing}$.

Thus for 1m width, $q_{safe-pr} = 0.392 \times 31.15 \left(\frac{1 + 0.3}{1} \right)^2 = 20.64 \text{ t/m}^2$ for 25 mm settlement.

5.1.3 Plate Load Test

Plate 37 to 40 shows the load settlement curve of plate load test conducted at 0.5m to 0.6m depth using 45 x 45 cm size of plate. The general nature of the load settlement curve is interpolation type shear failure, except in load test no. 2, where local shear type of failure was observed. Load test no. PLT-1 to PLT-4 shows net safe bearing capacity as shown in Table 4 below:

Table 4: Summaries of Plate Load Test Results

Test	Location	RL of test	Depth (m)	Net safe bearing
PLT1	750W, 660S	1.56	0.5	2.0
PLT2	530W, 525S	1.86	0.5	1.12
PLT3	15E, 517S	2.31	0.6	19.6
PLT4	885E, 520S	1.99	0.6	5.2

The net safe bearing capacity is evaluated from the graph by drawing tangent lines as shown on load settlement curves attached as plate 37 to 40.

ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

5.1.4 Cyclic Plate Load Test

Plate - 41 shows load settlement curve of cyclic plate load test conducted at 0.5 m depth below existing ground level using 45 cm x 45 cm plate size. From each loading - unloading cycle, elastic rebound was determined and a plot of load versus elastic rebound was generated as shown in Plate 41. The slope of load intensity - settlement plot is the coefficient of elastic uniform compression (C_u). $C_u = P/Se \text{ kg/cm}^3$

Where P = Load intensity in kg/cm^2 , and Se = Elastic rebound corresponding to P in cm.

The C_u varies with the contact area of the base. Hence, the value of C_u obtained from the test needs a correction due to contact area. Barken (1962) suggested that the values of C_u for the area up to 10m^2 can be extrapolated as $\frac{C_{u1}}{C_{u2}} = \sqrt{\frac{A_2}{A_1}}$. The C_u value evaluated from

cyclic plate load test for foundation area of 10 sq m is 0.268 kg/cm^3 .

Compression index C_u , the coefficient of elastic uniform shear C_τ , the coefficient of elastic non uniform compression C_ϕ , and the coefficient of elastic non uniform shear C_ψ are related to each other by the relation given below (Ref. IS: 5249 – 1992) :

$$C_u = 1.5 \text{ to } 2 C_\tau$$

$$C_\phi = 3.46 C_\tau$$

$$C_\psi = 1.5 C_\tau$$

$$\text{Therefore } C_\tau = 0.134 \text{ to } 0.179 \text{ kg/cm}^3$$

$$C_\phi = 0.464 \text{ to } 0.619 \text{ kg/cm}^3$$

$$C_\psi = 0.201 \text{ to } 0.269 \text{ kg/cm}^3$$

5.1.5 Block Vibration Test

Two block vibration tests are carried out in a test block of size $1.0\text{m} \times 1.0\text{m} \times 1.50\text{m}$. Both wave propagation and vertical vibration tests are carried out at both the places. Plate 42 and 43 shows test observation along with graphs and computation of dynamic parameters for both the tests. The computation of dynamic parameters are shown in Plate 42 and 43 for test 1 and test 2 respectively. For test 1(BVT1), the dynamic parameters C_u , C_τ , C_ϕ , and

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

C_ψ are 4.97kg/cm³, 2.49kg/cm³, 8.60kg/cm³, and 3.73kg/cm³ respectively. While for test 2(BVT2), C_u , C_τ , C_ϕ , and C_ψ are 5.22kg/cm³, 2.61kg/cm³, 9.03kg/cm³, and 3.92kg/cm³ respectively.

5.1.6 Cross-hole Test

From the recorded first arrivals of P wave (t_p) and S wave (t_s) various dynamic parameters are determined as shown in Plate 44. The summary of dynamic parameter as obtained from the test is shown in Table 5 here under.

Table 5: Summary of Dynamic Parameters

Depth (m)	Soil Type	Unit weight (kN/m ³)	Dynamic Shear Modulus (G), MPa	Dynamic Young's Modulus (E), MPa	Poisson's ratio
Location: Test bore-1, Distance: 2.97m					
3	Fine Sand	17	164	422	0.29
6	Clayey Sand	18	189	506	0.34
9	Weathered Rock	20	415	1082	0.30
12	Weathered Rock	20	419	1083	0.29
15	Weathered Rock	20	460	1179	0.28
18	Weathered Rock	20	460	1143	0.24
21	Weathered Rock	20	432	1081	0.25
24	Weathered Rock	20	652	1641	0.26
26	Weathered Rock	20	628	1567	0.25
Location: test bore 2, Distance: 6.03m					
3	Fine Sand	17	156	404	0.29
6	Clayey Sand	18	204	541	0.33
9	Weathered Rock	20	407	1062	0.31

ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Depth (m)	Soil Type	Unit weight (kN/m ³)	Dynamic Shear Modulus (G), MPa	Dynamic Young's Modulus (E), MPa	Poisson's ratio
12	Weathered Rock	20	439	1137	0.30
15	Weathered Rock	20	456	1175	0.29
18	Weathered Rock	20	449	1112	0.24
21	Weathered Rock	20	425	1061	0.25
24	Weathered Rock	20	713	1770	0.24
26	Weathered Rock	20	699	1734	0.24

5.1.7 Field Permeability Test

Four in-situ permeability tests were carried out using constant head method as discussed above. The observation table along with calculation is shown in Plate 45 to 48. The in-situ permeability values for different tests are as shown in Table 6 below:

Table 6: Summaries of Field Permeability Tests

Test No	Location	Type of Soil	Depth of Test (m)	Permeability (cm/s)
FPT1	745W, 530S	Silty fine sand	2.75	2.58×10^{-5}
FPT2	25E, 340S	Silty fine sand	2.30	1.67×10^{-5}
FPT3	145E, 592S	Fine sand	2.25	1.38×10^{-4}
FPT4	1310E, 368S	Yellow fine sand	3.0	1.15×10^{-4}

5.2 Laboratory Test

The detail result sheets are attached as Plate 49 for soil test results and Plate 50 for rock test results..

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

5.2.1 Field Density - Field Moisture Content

Field dry density and moisture content vary with depth. The dry density varies in the range of 1.21g/cc to 1.67g/cc with average value of 1.46g/cc. the moisture content is in the range of 7 percent to more than 50 percent at certain locations. Silty clayey stratum shows higher moisture content compare to sandy stratum. This higher moisture content is due to high water table in the vicinity.

5.2.2 Particle Size Analysis

Plate 51 to 67 shows the gradation curves of the various soil samples. Silty clayey soil shows more than 50 percent fines in almost all the results. The silty sandy strata show more than 50 percent presence of sand particles. The detail results are tabulated in results sheets attached as plate 49.

5.2.3 Atterberg's Limit

Silty clayey layer shows liquid limit, plastic limit and plasticity index in the range of 26% to 84%; 24% to 46%; and 9% to 47% respectively. Silty sandy layer shows non-plastic behaviour.

The soil is classified as per I. S. Classification system using sieve analysis and Atterberg's limit results as shown in result sheet attached as Plate 49.

5.2.4 Specific Gravity

The values are given in result sheet attached as Plate 49. The general range of specific gravity for all the three layers is in-between 2.52 to 2.66 with some exceptional values.

5.2.5 Direct Shear Test

Triaxial shear (uu) test are performed on silty-clayey soil samples, while direct shear tests are conducted for silty-sandy soil of samples. Triaxial shear test shows the cohesion value in the range of 0.25 kg/cm² to 0.40 kg/cm² with some exceptional high and low values.

Samples show angle of internal friction in the range of 0 to 4 degrees. Samples are tested after saturation.

Direct shear test on silty -sandy stratum shows no cohesion with angle of internal friction in the range of 25 to 32 degree.

Plate 68 to 99 shows the failure envelopes for direct shear test and triaxial shear test.

5.2.6 Consolidation Test

Consolidation tests were conducted on various soil samples collected from different bore holes at various depths. The results of consolidation tests of various soil samples are shown in result sheets attached as Plate 49. Test result shows C_c value in the range of 0.07 to 0.23 with pre-compression pressure in the range of 0.55 kg/cm^2 to 1.30 kg/cm^2 (Plate 100 to 109). The ' m_v ' parameters for the pressure range of $2-4 \text{ kg/cm}^2$ are in the range of $0.0057 \text{ cm}^2/\text{kg}$ to $0.0254 \text{ cm}^2/\text{kg}$.

5.2.7 Standard Proctor

Plate 110 to 119 shows Standard Proctor test curves. The test results obtained are as shown in Table 7.

Table – 7 Standard Proctor Test

Location	Depth (m)	Std. Proctor Test	
		MDD (g/cc)	OMC (%)
BH-3	0.5	1.44	22.1
BH-4	0.5	1.62	12.5
BH-5	0.5	1.66	14.0
BH-6	0.5	1.65	8.0
BH-7	0.5	1.53	16.0

ISO 9001 : 2000
Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Location	Depth (m)	Std. Proctor Test	
		MDD (g/cc)	OMC (%)
BH-8	0.5	1.58	14.0
BH-16	2.0	1.50	11.0
BH-17	1.0	1.60	15.2
BH-20	0.5	1.61	12.0
BH-20	2.0	1.52	17.0

5.2.8 Chemical Analysis

Results of chemical analysis of various soil and water samples are presented in Table-8 and 9.

Table - 8 Chemical Analysis of Soil

Borehole No	Depth (m)	pH	Chloride (%)	Sulphate (%)	
				SO ₃ (2 Water: 1 Soil)	SO ₃ (10 Water: 1 soil)
BH-1	0.5	7.9	4.0	3.00	1.31
BH-2	2.0	7.8	4.5	3.31	1.39
BH-4	4.0	7.8	4.2	3.45	1.39
BH-7	3.0	8.0	4.8	3.80	1.64
BH-9	1.0	7.9	5.0	3.40	1.48
BH-10	0.5	8.2	4.4	3.13	1.31
BH-11	2.0	8.0	4.2	3.72	1.49
BH-14	3.0	7.8	3.8	3.64	1.43
BH-16	2.0	7.7	4.0	3.60	1.44
BH-18	3.0	7.8	4.5	3.72	1.39

Table – 9 Chemical Analysis of Water

Bore hole No	pH	Chloride (mg/l)	Sulphate SO ₃ (mg/l)
BH-1	7.4	5000	1639
BH-2	7.2	6000	1721
BH-4	7.2	6500	1967
BH-7	7.4	7000	2131
BH-9	7.2	6820	1967
BH-11	7.2	7200	1639
BH-13	7.7	5700	1800
BH-15	7.5	6000	2295
BH-17	7.5	6500	3459
BH-19	7.4	7000	2787

Soil and water sample shows high concentration of sulphate, and hence precautions against sulphate attack is necessary. As per IS 456: 2000, Supersulphated or sulphate resisting Portland cement is recommended. Minimum cement content shall be 370 kg/m³ and maximum Face Water – Cement ratio shall be 0.45. Also, as ground water samples shows high concentration of sulphate and chloride, it is not suitable to use for construction purpose.

5.2.9 Rock Test Results

The rock samples as obtained from the different boreholes in the form of rock cores are further tested in the laboratory for compressive strength. The rock at the site is calcareous sand stone and its compressive strength varies in the range of 40 kg/cm² to 160 kg/cm², water absorption varies from 0.7% to 3.0% and specific gravity varies from 2.34 to 2.70 with

some exceptional high and low values. This variation is due to extent of weathering effect and mode of formation of rock at the site. The bore wise detail test results are shown in Plate 50.

6.0 SOIL BEARING CAPACITY

The following formula is used for calculating ultimate net bearing capacity in the case of strip footings: (Ref: IS: 6403 - 1981)

a) In case of general shear failure:

$$d = C N_c + q (N_q - 1) 0.5 B_r N_r$$

b) In case of local shear failure:

$$d = 2/3 C N'_c + q (N'_q - 1) + 0.5 B_r N'_r$$

The ultimate net bearing capacity obtained for strip footing is modified to take into account, the shape of the footing, inclination of loading, depth of embedment and effect of water table. The modified bearing capacity formula is given as under:

a) In case of general shear failure:

$$Q_a = C N_c S_{cd} i_c + q (N_q - 1) S_q d_q i_q + 0.5 B_r N_r S_r d_r i_r W'$$

b) In case of local shear failure:

$$Q_u' = 2/3 C N'_c S_c d_c i_c + q (N'_q - 1) S_q d_q i_q + 0.5 B_r N'_r S_r d_r i_r W'$$

Shape Factor

	S_c	S_q	S_r
i Continuous strip	1.00	1.00	1.00
ii Rectangular	$1 + 0.2 B/L$	$1 + 0.2 B/L$	$1 - 0.4 B/L$
iii Square	1.3	1.2	0.8
iv Circle	1.3	1.2	0.6

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Depth Factor

$$d_c = 1 + 0.2 \frac{D_f}{B} \sqrt{N\phi}, \text{ Where } \sqrt{N\phi} = \left(45 + \frac{\phi}{2} \right)$$

$$d_q = d_r = 1 \text{ for } \phi < 10 \text{ degree} \quad d_q = d_r = 1 + 0.1 \frac{D_f}{B} \sqrt{N\phi}, \text{ for } \phi > 10 \text{ degree}$$

In addition to above, the safe bearing capacity is also evaluated using field test as discussed below:

6.1 Design Parameters for Shallow Foundations

6.1.1 Shear and Settlement Criteria

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Parameters	
Cohesion (kg/sq.cm)	0.00
Angle of Internal friction (degree)	28
Dry density (g/cc)	1.46
Bulk density (g/cc)	1.76
Specific Gravity	2.59
Coeff. of volume change, m_v (cm^2/kg)	0.012
Water Table	At G L
Factor of safety	2.5

$$\text{Void ratio, } e = \frac{G\gamma_w}{\gamma_d} - 1 = \frac{2.59 \times 1}{1.46} - 1 = 0.77$$

ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Thus, local shear failure was considered for safe bearing capacity computation. The net safe bearing capacity for various sizes of individual rigid footings having vertical static load intensity is evaluated as in Table - 10. The settlement analysis was carried out using Static Cone Resistance value as discussed above in Para 5.1.6.

From the observations of SPT and SCPT results, it reveals that the soil is soft / loose in nature up to top 1.0m and from about 4.0m to 5.0m depth. So, it is recommended to provide foundation depth at 1.0m or 1.5m depth and width of foundation such that pressure bulb remains above soft strata. So if foundation depth is 1.5m and width of foundation is 1.0m, then pressure bulb will remain within the depth of 1.5m to 3.5m. Foundations for heavy load shall be placed on hard stratum, and as rock is available at relatively shallow depth, end bearing pile is suggested.

S B C Calculation (I S 6403)	
Type of Footing	Square Footing
Size (m x m) Depth (m)	1.0 x 1.0 x 1.0
Cohesion (kg/cm ²)	zero
Angle of Internal Friction (Degree)	28
Water Table Consideration	G.L
Shape Factor (Sc, Sq, Sy)	1.30, 1.20, 0.8
Depth Factor (dc, dq, dy)	1.333, 1.166, 1.166
Bearing Capacity Factor N'c, N'q, N'y	14.473, 6.156, 5.099
$q_{ult} = c N'_c S_c d_c i_c + q (N'_q - 1) S_q d_q i_q + 0.5 B_r N'_r S_r d_r i_r w'$	
$q_{ult} = 0 + 0.91 \times 1 \times (6.156 - 1) \times 1.2 \times 1.166$	
$+ 0.5 \times 1 \times 1.91 \times 5.099 \times 0.8 \times 1.166 \times 0.5 = 8.84 \text{ t/m}^2$	(Factor of Safety = 2.5)
Net Safe Bearing Capacity = 8.84 / 2.5 = 3.53 t/m ²	



ISO 9001 : 2000

Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Table - 10 shows the summary of SBC and SBP evaluated based on shear and settlement parameters.

Table - 10 Summaries of SBC & SBP

Size (m)	Depth (m)	Safe Bearing Capacity (SBC) (t/m ²)	Safe Bearing Pressure from SCPT (SBP) (t/m ²) for 25mm settlement	Recommended value (t/m ²)
1.0X1.0	1.0	3.54	20.64	3.54
1.0X1.0	1.5	5.2	20.64	5.2
1.5X1.5	1.0	3.8	17.58	3.8
1.5X1.5	1.5	5.3	17.58	5.3

6.1.2 Plate Load Test

Plate – 37 and 40 show load settlement curve for plate load test conducted at 0.5 m depth. Load –settlement curve indicates safe bearing capacity in the range of 1.12t/m² to 5.2t/m² with exceptional values of 19.6t/m² at PLT-3 location. As the soil stratum at test depth of 0.5m is soft / loose in nature which reflects in lower safe bearing capacity.

6.2 Design Parameters for Deep (pile) Foundations

The vertical static load carrying capacity of individual pile is evaluated as end bearing pile resting on rock which is available at about 5.0m to 9.0m depth below existing ground level. However the average rock level available at about 7.0m depth. For piles resting on weathered rock it may be necessary to provide socketing to piles so that they can be loaded to their safe structural capacity. The socket length in such cases is 3 times the diameter of the pile. In this method load capacity is assumed to be derived from point resistance only.

This assumption can be considered as safe, since the bearing capacity of the rock is available, irrespective of construction procedure. The load carrying capacity of individual pile based on properties of rock cores can be found out using relation $Q_{ap} = A_p q_a$, where $q_a = q_u K_{sp} K_{ap}$, q_u = average unconfined compressive strength of rock core, K_{sp} = empirical factor, known as bearing pressure coefficient which includes FOS of 3 (assumed as 0.25 for wide spacing of discontinuities), K_{ap} = depth factor = $0.8 + 0.2 L/D$ (where L = length of socket in rock and D is diameter of the socket).

Consider average unconfined compressive strength of rock (q_u) up to the depth of 10m equal to 90.4 kg/cm^2 . Let $K_{sp} = 0.25$, and $K_{ap} = 0.8 + 0.2 * (3D/D) = 1.4$. Therefore, $q_a = q_u * K_{sp} * K_{ap} = 90.4 * 0.25 * 1.4 = 31.64 \text{ kg/cm}^2$.

$Q_{ap} = q_a * A_p$. For 45 cm diameter pile, $Q_{ap} = 31.64 * (\pi/4 * 45 * 45) = 50321 \text{ kg (50.32 T)}$.

Table-11 provides load carrying capacity of individual pile subjected to load test verification.

Table - 11 Summaries of Load Capacity of Pile Foundation

Pile Diameter (m)	Socket Length in rock (m)	Pile capacity in Compression (t)
0.45	1.35	50.30
0.5	1.50	62.13
0.6	1.80	89.46

7.0 RECOMMENDATION

1. Sub soil strata are poorly graded fine silty sand up to about 5.0m to 6.0m depth. Below that there is a layer of weathered calcareous lime stone having thickness of about 2.0m. Below that and up to the depth investigated, the calcareous lime stone is available. There is no much variation in sub strata is observed, however there is a presence of about 1.0m to 3.0m thick clayey silt pocket nearby borehole BH-1 and BH-8 at about 3.0m to 4.0m depth from the existing ground level.
2. The safe bearing capacity considering laboratory shear and settlement parameters is recommended as given in Table – 10 for minor and light loaded foundations. The recommended value of SBC shall be for static vertical loading only. The foundation depth shall be as shown in Table -10.
3. Load –settlement curve indicates safe bearing capacity in the range of 1.12 t/m² to 5.2 t/m² with exceptional values of 19.6t/m² at PLT-3 location.
4. Table - 11 gives the vertical static load carrying capacity of individual pile for heavy structures. The pile capacities as mentioned in Table - 11 is subjected to a conformation by performing a Pile load test as mentioned in IS: 2911 Part-iv
5. The soil does not show swelling characteristics and is suitable for back filling as well as for road construction purpose.
6. The coefficient of Active and Passive earth pressure shall be considered as 0.36 and 2.77 respectively. This is computed using angle of internal friction value of 28 degree of the sub strata.
7. Soil and water sample shows high concentration of sulphate, and hence a precaution against sulphate attack is necessary. As per IS 456: 2000, Super sulphated or sulphate resisting Portland cement is recommended. Minimum cement content shall be 370 kg/m³ and maximum Face Water – Cement ratio shall be 0.45. Ground water is not suitable for use in construction purpose.

ISO 9001 : 2000

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Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

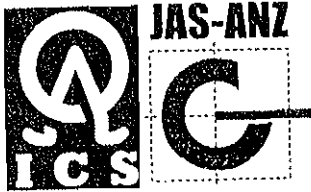
Report No. GETS/2005/811 dated 24.08.2005

8. A Field permeability value varies in the range of 1.15×10^{-4} cm/s to 2.58×10^{-5} cm/s.
9. As the topsoil is sandy in nature and high water table, stability of excavated trench shall be maintained properly by providing strutting wherever necessary.
10. Cross-hole test shows average dynamic parameter as under:

Soil Type	Dynamic Shear Modulus G MPa	Dynamic Young's Modulus E MPa	Poisson's Ratio	Unit weight kN/m ³
Fine sand	160	413	0.29	17
Clayey sand	196.5	523.5	0.335	18
Weathered rock	503.8	1273.4	0.267	20

11. The average dynamic soil parameters as obtained from block vibration test is as under:

Parameters	Test 1	Test 2	Average value
Coefficient of elastic uniform compression (kg/cm ³)	4.97	5.22	5.095
Coefficient of elastic uniform shear (kg/cm ³)	2.49	2.61	2.55
Coefficient of elastic non uniform compression (kg/cm ³)	8.60	9.03	8.81
Coefficient of elastic uniform shear (kg/cm ³)	3.73	3.92	3.83



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Reg. No. : R91/1462

Project: Soil Investigation for proposed 2 x 500 MW NLC Thermal Power Station at Tuticorin

Report No. GETS/2005/811 dated 24.08.2005

Parameters	Test 1	Test 2	Average value
Damping coefficient	0.162	0.329	0.245
Shear Modulus (kg/sq.cm)	276.9	342.9	309.9
Elastic modulus (kg/sq.cm)	775.5	960.0	869.25

For GEOSTRUCT ENGINEERING & TESTING SERVICES

(G. J. TALATI)

Dr. F. S. Umrigar
B.E. M.Tech. Ph.D. FIE
Principal



BIRLA VISHVAKARMA MAHAVIDYALAYA
(ENGINEERING COLLEGE)

P O BOX NO 20 • VALLABH VIDYANAGAR-388 120 • GUJARAT • INDIA
PHONE (02692) 233104, 230762 Fax : 236672
EMAIL bvm.princi@vsnl.com
Website <http://bvmengineering.ac.in>

**VETTING OF SOIL INVESTIGATION REPORT FOR PROPOSED 2 X 500
MW NLC THERMAL POWER STATION AT TUTICORIN**

Investigated by :

Geostruct Engineering & Testing Services
8, Sahajanand Co-op. Industrial Estate
Munjmahuda
BARODA - 390 021

Vetted by :

Dr. A.K.Verma
Professor
Structural Engg.Dept.
Birla Vishvakarma Mahavidyalaya
VALLABH VIDYANAGAR-388120

Submitted on : September, 2005



It is found from the soil investigation report that a good number of laboratory tests on soil samples and rock samples have been carried out, which is adequate. The findings of laboratory results match with the Field Tests results such as Static Conc Penetration test, Standard Penetration Test, Plate Load Test, etc.

The dynamic parameters obtained from:

- 1) Block Vibration Test
- 2) Cross Hole Test
- 3) Wave Propagation Test

are quite reliable and are required in the design of machine foundation and vibration analysis.

The overall planning in carrying out the test is quite satisfactory, but the soil conditions upto 6.0 depth are poorly graded sand ($Q_{nsafe} = 3$ to 5 t/m^2) which needs to be improved by resorting to some ground improvement techniques or pile foundation as mentioned in the report.

The report is well documented and tests results are in tune with the soil characteristics.

From the plate 2 to 21 in the report, the borelog shows highly weathered calcareous sandstone from approximately 6.0 m depth onwards for thickness of strata ranging from 1m to 5m. This zone may be detrimental to the structures because sandstone is a sedimentary rock, which usually contains caverns occurring at or near the water table. The roofs of caverns may collapse when loaded. Since pile's tip is to rest in the weathered rock, it is suggested that the pile load test should be carried out to determine the safe pile load carrying capacity. The report also recommends for pile load test, which is in right direction.

Dr. F. S. Umrigar
B.E. M.Tech. Ph.D. FIE
Principal



BIRLA VISHVAKARMA MAHAVIDYALAYA
(ENGINEERING COLLEGE)

P O BOX NO 20 • VALLABH VIDYANAGAR-388 120 • GUJARAT • INDIA
PHONE (02692) 230104, 230762 Fax . 236672
EMAIL bvm.princi@yahoo.com
Website http://bvmengineering.ac.in

:2:

After going through the complete report, the following recommendations are made:

- 1) The top sandy layers are too weak for shallow foundations and some ground improvement techniques should be applied or pile foundation should be used. However, for very small loadings, the foundations can be constructed on such soils.
- 2) The pile's tip should preferably cross the highly weathered calcareous sand stone.
- 3) The pile load test should be carried out to evaluate the safe load carrying capacity of a pile as mentioned in the soil investigation report.

Vetted by (Dr. A.K. Verma)

Head
Structural Engg. Dept.

PRINCIPAL



**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

DOMESTIC COMPETITIVE BIDDING

Tender No: COCONTS/ 0010 K/RT/NTPL/Addl. Chimney /2020, Dt. 01.07.2020.

Date & Time of Opening: 04.08.2020 at 15.00 Hrs. (IST)

TENDER SPECIFICATION

for

**Construction of One RCC Additional Chimney of 150 M height with
Borosilicate lined Bi-flue can arrangement for Flue Gas Desulphurization
Plant of 2X500 MW Coal based Thermal Power Plant located at Tuticorin,
Tamil Nadu, India.**

VOLUME – II B SEC - II

STACK ELEVATOR



Development Consultants Pvt. Ltd.

July 2020



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION-II

STACK ELEVATOR



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-II
Stack Elevator**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTENT OF SPECIFICATION	1
2.00.00	CODES AND STANDARDS	1
3.00.00	SCOPE OF WORK	2
4.00.00	DESIGN & CONSTRUCTION	3
5.00.00	OPERATION & CONTROL PHILOSOPHY	16
6.00.00	TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND SITE	17
7.00.00	DRAWINGS, DATA, AND INFORMATION	18
ATTACHMENT		
ANNEXURE-I:	TECHNICAL DATA SPECIFICATION SHEET FOR STACK ELEVATOR	20
ANNEXURE-II:	MANDATORY SPARES	21





VOLUME: II-B

SECTION-II

STACK ELEVATOR

1.00.00 INTENT OF SPECIFICATION

This Specification covers design, constructional features, material requirement, manufacture, erection, performance requirement, testing etc. of One (1) no. Rack & Pinion type Vertical Stack elevator complete with all driving equipment, auxiliaries and accessories for 150 meter long twin flue wet chimney (Stack) with borosilicate lining.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture, inspection and testing of Elevator shall comply with all currently applicable statutes, regulations and safety codes. Other internationally acceptable standard/codes, which ensure equal or higher performance than those specified shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Owner/ consultant shall be final and binding. The design unless specifically stated otherwise, confirm to following specific codes and standards as applicable, including its latest amendments subsequent to the date of publication as mentioned below:

2.01.01	IS: 14665 (Part-1)	: Electric Traction Lifts, Guidelines for outline dimensioning.
2.01.02	IS: 14665 (Part-2)	: Electric Traction Lifts, Code of practice for installation, operation & maintenance.
2.01.03	IS: 14665 (Part-3)	: Electric Traction Lifts, Safety rules.
2.01.04	IS: 14665 (Part-4)	: Electric Traction Lifts, Components.
2.01.05	IS: 14665 (Part-5)	: Electric Traction Lifts, Inspection Manual.
2.01.06	IS: 7759	: Specification for Elevator door locking devices and contacts
2.01.07	IS-2365	: Specification for Steel Wire Suspension Ropes for Lifts and hoists.
2.01.08	State's Elevator and Escalator Act.	
2.01.09	State's Elevator and Escalator Rules	
2.01.10	Indian Electricity act.	
2.01.11	Indian Electricity Rules.	

2.02.00 Wherever specified or required the Plant shall conform to various statutory regulations. Wherever required, approval for the equipment supplied under the specification from statutory authorities shall be the responsibility of the bidder.



3.00.00 SCOPE OF WORK

3.01.00 One (1) no. Rack & Pinion type Vertical Stack elevator complete with all driving equipment, auxiliaries and accessories for 150 meter long twin flue chimney /Stack shall be supplied by the bidder.

The scope of work shall include design, engineering, fabrication, installation, commissioning and testing of rack and pinion type elevator including required enclosures, elevator, mast and guide rail, cab drive unit machinery, power cables, control cable, mechanical and electrical equipment for bi flue chimney. The elevator including electrical and mechanical components shall be installed inside the chimney. The design of the elevator shall be in such a way that the elevator operation shall be safe even with expected maximum deflection of the chimney structures. Contractor shall submit the elevator GA and cross section drawing along with the bid for review.

The stack elevator and accessories to be furnished and put into operation and all other required services are detailed herein under. The items, though not specifically mentioned herein but needed to make the system complete in all respects and reliable for safe and smooth operation and guaranteed performance shall also be treated as though included and the same shall be furnished, unless otherwise specifically excluded elsewhere. The items, though not specifically mentioned below but mentioned elsewhere in the specification shall be included in the scope of work.

The required equipment and services shall be as described below:

- i) One (1) no. 400 kg (minimum) capacity rack & pinion type stack elevator complete with all other accessories and associated steel works.
- ii) Electrical equipment such as motors, starters, switches, switch gears, control panels, interlocks, control & power cabling and earthing of electrical equipment.

3.02.00 Accessories

Each elevator shall consist of following:

- a. Elevator car complete with door, door hangers and tracks, push button station, operating panel, car position indicators, illumination fittings, fan fittings and other required accessories. Lighting point and plug point shall be provided over the elevator car roof for the purpose of maintenance work.
- b. Mast, guide rails, Cab, Cab Frame, Cab doors, guide rollers and structural steels, terminal buffers and guide rail lubrication device.
- c. Complete drive machinery and accessories e.g. electric motor, gear box etc., electrical and control equipment including cables & isolating switch including Power & lighting distribution boards etc.
- d. Necessary brakes and limit switches, safety locks for car and landing door & all other protective devices including switch, fuse, starters etc.



All rigid/flexible conduit, ferrules, lugs, glands, terminal blocks, cable clamps, general purpose flexible/Trailing cables automatic leveling device and other miscellaneous items as required.

- e. Hoist-way doors and push button station with digital lights at each landing.
- f. Provision of Battery back-up for emergency lighting inside the Elevator car and alarm, in case of power failure.
- g. Facility of intercom in the Elevator car with necessary wiring for connection from car to a terminal box adjacent to bottom most landing and to the Plant Control room as well as Maintenance Engineer room.
- h. Any other fittings and accessories required for safe and efficient operation of the equipment.
- i. Firemen's switch as per rules of fire lifts.

4.00.00 DESIGN & CONSTRUCTION

4.01.00 General

4.01.01 This section covers the design, engineering, fabrication, installation, commissioning and testing of the rack and pinion type vertical lift elevator including required enclosures, elevator, mast and guide rail, cab drive unit machinery, buffers, power cable, control cable, mechanical and electrical equipment. The design of the elevator shall be in such a way that the elevator operation shall be safe at all times.

4.01.02 Elevator shall be capable of operating from the ground floor to the top landing with intermediate stops at all landings as stipulated.

4.01.03 All mechanical and electrical operating devices and trailing cable shall be designed for outdoor operation with dusty and high humidity conditions and shall operate equally well in any ambient temperature as per project synopsis. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100 degrees C when the elevator is not operating.

4.02.00 Enclosures

A three-sided ground enclosure with one access door shall be provided for ground landing. At each platform landing above ground level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high and epoxy primer coated with two coat of the manufacturer's standard primer and finish paint.

The ground landing shall be provided at a suitable height above the foundation slab to ensure safety and space underneath the cage for buffer and stop. Foundation should be at least 100 mm above local grade. The



space underneath the landing shall be surrounded by foundation enclosure. A staircase shall be provided for access to the cage. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the cabin is at a landing. Doors shall be bi-parting and swinging type.

Base of the three-sided enclosure shall be securely anchored to the ground level floor slab using expansion type anchors.

4.03.00 Mast

Mast shall be provided in sections of approximately 1.52 m length welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the structure at suitable distances.

4.04.00 Cab

4.04.01 Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.

4.04.02 Cab floor shall be skid resistance glass fiber reinforced plywood or approved equal. Cab shall be attached to a framed structure and form an integral part with the drive mechanism located at the top of the cab.

4.04.03 Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.

4.04.04 Cab roof shall be provided with an escape hatch electrically interlocked with elevator control system. Tubular steel handrail shall be provided on the cab roof for maintenance purposes.

4.04.05 Cab door and landing level enclosure doors shall be electrically and mechanically interlocked to prevent the cab from being operated unless the cab door and landing level enclosure doors are fully closed and to prevent the doors from being opened while the cab is in motion. Cab door shall be of Closed Collapsible Sliding Gate type with manual operation.

4.04.06 One no. cabin fan, two no. recessed fluorescent lamp fittings and one no receptacle with duplex outlet (5A,240V each) to be provided alongwith one no. emergency light with battery charger. Cab interiors shall be paneled with stainless steel sheets.

4.05.00 Drive Unit & Safety Device

4.05.01 Drive unit located on top of the cab shall be complete with AC squirrel cage induction motor, reduction gear, drive pinion and an over speed governor.

Drive unit shall incorporate an Electro Hydraulic Thruster (EHT) type brake and an external manual brake release. The mechanical compression spring shall be held off by hydraulic pressure. This hydraulic pressure shall be



provided by EHT brakes. In the event of power failure, the brake shall be automatically applied & will stop the cab. The brake shall be of self adjusting type and released by means of a special handle provided in the cab.

- 4.05.02 An overspeed governor in constant mesh with the rack by means of a pinion shall be incorporated to protect the cab against overspeed during the cab downward motion.

At a predetermined speed higher than normal, the centrifugal action of the governor pawl shall actuate the incorporated brake mechanism and stop the downward motion of the cab smoothly. The brake shall remain locked on following this action and has to be manually reset before normal elevator operation can be resumed.

- 4.05.03 A remote control shall be provided testing the safety device of the with remote control facility.

- 4.05.04 The drive system shall be designed so that it will be capable to operate smoothly without any tendency to rock or judder with all vertical, horizontal forces as well as the moments through the rack.

- 4.05.05 A safety device shall be provided in conjunction with the drive unit & shall have a separate flame hardened steel pinion engaging in the rack. The device shall be actuated by centrifugal weight & stops the elevator smoothly in case the normal traveling speed exceeds. The safety device shall remain locked on following this action & has to be manually reset before normal elevator operation can be resumed. For testing the safety device, the elevator shall be provided with a remote control facility. Bidder shall ensure that no person is in cab during the test.

- 4.05.06 The elevator shall be provided with a centrifugal brake to prevent accidental tripping of the safety device if, in case of power failure, the cage has to be taken to the ground by gravity. The motor brake shall be released mechanically by a lever in the cage to allow the cage to move down. The centrifugal brake shall keep the preset speed lower than the tripping speed.

- 4.06.00 Buffers

Sufficient number buffers of spring loaded /hydraulic type shall be fitted below the cab. The buffers shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment.

The number of buffers shall be fixed as to ensure proper sharing of impact loads by all of them.

- 4.07.00 Power and Control

All electrical components furnished with the elevator shall be completely wired, energized and checked. Necessary power distribution arrangement shall be provided by the Contractor to feed electrical power to elevator.

All electrical control devices shall be in enclosures. Equipment furnished shall

include the following:

- a) Momentary contact push button for raise/lower control.
- b) Reversing combination motor starter with a moulded case circuit breaker for the motor. Starter shall be equipped with three thermal overload relays for motor protection. Operating handle for the combination starter circuit breaker shall be accessible from inside the cab and shall also serve as an emergency stop switch.
- c) Deleted.
- d) Over travel protection, emergency stop push button, over speed governors.
- e) All electrical and mechanical interlocks on cab access door and landing level enclosure doors, phase reversal protection shall be provided.
- f) An alarm push button shall be provided in the cage connected to a battery operated alarm at the elevator base. Simultaneous alarm shall also sound at the unit control room (UCR) in the event of any fault in the stack elevator for which one potential free contact shall be provided in each elevator for audio visual alarm in PCR for "Stack Elevator Fault" indication.
- g) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.
- h) Continuous duty electric torque motor recoil cable reels as required to maintain electrical power service to all elevator electrical components throughout the limits of travel.
- i) One auxiliary panel shall be furnished and mounted on the grade level enclosure. Panel shall be equipped with a main "ON-OFF" isolating switch, main contactor, relays, control transformer and fuses, tone frequency transmitter, terminal blocks and all other accessories required for normal operation of the elevator.
- j) One main control panel shall be furnished and mounted on the top of the cab. Panel shall be equipped with necessary equipment like rectifier, battery, charger, tone frequency receiver, contactors, MCBs, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.
- k) Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling. Degree of protection of the control cabinets shall be IP-52 as per IS:2147. Control cabinets shall be provided with hinged door(s) with padlocking arrangement. All doors, removable covers and plates shall

be gasketed all around with neoprene gaskets, louvers, when provided, shall have screens and filters. The screens shall be of fine wire mesh made of brass. Suitable cable gland plate shall be supplied fitted on to this gland plate. All cable glands shall be screwed on type and made of brass.

- l) Each motor to be controlled from the control cabinet shall be provided with 3 pole isolating switch. HRC fuses, contactors of AC4 duty class with thermal overload relays with single phasing preventer and other equipment required for satisfactory control motor. The isolating switch and contactor shall be rated atleast 20% more than the connected motor full load current. Motors of 0.37 KW and above shall be rated for 415 V, 3 Phase and below 0.37 KW will be 240 V single phase supply.

The controllers and resistors for motors shall conform to IS-8544 (latest edition) and IS-2959 (latest edition) and shall be continuously rated for 150% full load current of the motor. Switches shall be hand operated, air breaker heavy duty, quick make, quick break type conforming to IS-4064. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal/abnormal conditions such as full load, overload, locked rotor, short circuit etc. The incoming power supply isolating switch shall be inter-locked with the control cabinet door so as to prevent opening of the door when the switch is closed. Device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

- m) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 KA. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive without danger of contact with live metal.
- n) Contractor shall provide dry type transformers with class B insulation for control power supply, lighting and space heating. Control supply will be 240 V AC. Transformer for control supply shall be provided with a control tap at 110 V which will be earthed. Power and control supply to individual drives and users shall be distributed with separate isolating switches and primary and secondary fuses.
- o) All push buttons shall be of push to actuate type having 2 "NO" and 2 "NC" self-reset contacts. They shall be provided with integral escutcheon plate engraved with their functions. Push button contacts shall be rated for 5 Amp at 415 V AC and 1 Amp. inductive breaking at 250 V DC. Mushroom type emergency push button to open the main contactor shall be provided in the operator's cabin and two on the bridge platform within easy reach. Indicating lamps shall be of the filament type and low watt consumption lamps shall be provided with series resistors.

- p) Strip type space heaters of adequate capacity shall be provided inside in each cabinet.
- q) Control cabinets shall be supplied completely wired. All wiring shall be carried out with 650 V grade PVC insulated, stranded conductors. Power circuits shall be wired with stranded aluminium conductors of adequate sizes to suit the rated circuit current, the minimum size shall be 6 sq.mm Control circuits shall be wired with stranded copper conductors of sizes not small than 2.5 sq.mm. Control circuits shall be isolated from power circuits.
- r) Cab shall be controlled by a semi-automatic floor selection control system. Cab shall be furnished with 240 Volt grounding type receptacle, emergency alarm push button with a normally open contact rated 0.5 Amp. at 220 V DC, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Cable guides shall be installed at every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level and the main control panel on the cab, will be provided with the tone frequency receiver. However control and interlocks from the landings shall be connected to the auxiliary panels located at ground level through fixed cables. The power and control cables and trailing power cables shall be FRLS type.
- s) Each landing assembly shall include a limit switch for door interlock and push-button control station installed and wired to a landing junction box.
- t) Cable trolley with cable guides for recoil of cable on to cable reel to maintain electrical power service to all elevator component through out the limits of travel.
- u) Contractor shall furnish, install, and connect a system equipment ground to the Owner's existing chimney ground system. System equipment ground shall electrically connect panels and junction boxes which contain electrical devices, motors, and elevator platforms and support structure. Raceway system shall not be considered as an equipment ground.
- v) All enclosures containing electrical devices shall be provided with 240 Volt, single-phase space heaters with adjustable thermostat control.
- w) All power cables and raceway shall be furnished and installed by the Contractor for interconnection of the main control panel, auxiliary panel and landing junction boxes etc. Conductors included in the cable shall be as required to energise all electrical equipment furnished with the elevator. Transmission of alarm signals is done by means of tone frequency equipment. Hence communication conductors are not required.

4.08.00 Electric Motor

Elevator drive motor shall be squirrel-cage induction type designed and fabricated to conform to the requirements indicated on the drawings.

Motor shall be designed for operation at the required speed; 415 Volts, 3 phase, 50 hertz, and shall be suitable for full voltage starting, S4 duty class as per IS-4722 with CDF of 25% and maximum number of 120 starts per hour in 55 Deg. C ambient temperature. Motor shall be tested at the factory to determine that it is free from electrical or mechanical defects.

Motor nameplate KW rating shall not be exceeded when the equipment is operating within the limits of the maximum load requirements.

Motor shall have sealed Class B non-hygroscopic insulation (IS-325) or equivalent international standard including two additional dips and bakes of epoxy varnish or vacuum impregnation. Insulation system shall be the motor manufacturer's standard premium insulation offering.

Motor shall be totally enclosed and furnished with cast iron frame, brackets, gasketed conduit box and fan cover. Motor shall be furnished with grease pre-lubricated, double-shielded, anti-friction bearings having life rating of not less than 42,500 hours under coupled service retirements. All exposed metal surfaces shall be protected with a polyester paint or coating which is moisture and corrosion resistant.

Motor shall be provided with internal 240 Volt AC single-phase space heaters or an alternate heating system to prevent condensation within the motor during extended periods of idleness. Motor heating system shall be acceptable to Owner.

Motor and driven equipment shall be direct coupled or belted as required, and mounted on a common base plate with coupling or belt guard. Motor shall be completely assembled, lubricated, and ready for operation.

Intent of these specifications is that the motor supplied be designed and constructed for the intended service. Motor construction and duty cycle shall conform with all requirements of applicable safety codes and standards for the service. For additional requirements Volume-II B section-III shall be referred to.

4.09.00 Raceway**a) General**

Complete raceway system for the elevator shall be furnished and installed in accordance with this section and the Contractor's shop drawings as reviewed and accepted by the Owner. The Contractor shall provide drawings for acceptance showing the routing of conduit

and wiring for the control circuits associated with the elevator.

Raceway system is defined to include conduit and all related materials and devices required to support, secure and provide a complete system for support and protection of electrical cable and wiring.

Raceway shall be furnished and installed as required to extend raceway which has been installed under separate specifications for entry for circuits to the chimney facilities from external plant area. Raceway shall be provided for all cable and wiring installed under these specifications.

b) Materials

Raceway shall be rigid galvanised steel conduit, provided in accordance with IS-1653 (latest edition).

Steel conduit, couplings and elbows shall be hot-dip galvanised rigid mild steel. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. Thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage. Flexible conduits shall be plastic jacketed, liquid tight galvanised steel.

Galvanised steel fittings shall be used with galvanised steel conduit. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction.

Bushings shall be provided at the termination of all conduit not terminated in hubs and couplings. Insulated bushings with insulating inserts in metal housings shall be provided on conduit 32 mm diameter and larger. Insulated bushings shall be grounding type standard bushings and shall be galvanised.

One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

Raceway supports shall be galvanised steel materials. Hanger rods shall be 13 mm diameter threaded steel rods. Supports for conduits in single runs or groups of two shall be one- hole cast metal straps and clamp-backs unless other types are acceptable to the Owner. Supports for banks of three or more conduits shall be constructed of support channels with associated conduit clips. Support channels for galvanised steel conduit shall be hot-dip galvanised after fabrication.

Junction box enclosure, type, and material shall be as indicated on the drawings or as stated in these specifications. Junction boxes, pull



boxes, and cabinets shall not have knockouts. Junction boxes for indoor service shall be of sheet steel hot-dip galvanised after fabrication and shall be dust resisting enclosure. Except as indicated otherwise in these specifications, all junction boxes for use in outdoor or damp locations shall be galvanised malleable iron or equivalent cast ferrous metal. Junction boxes and outlet boxes installed on the exterior shall be galvanised steel.

Outlet boxes, switch boxes, and associated fittings shall be galvanised iron or equivalent cast ferrous metal.

c) Installation

Contractor shall field route conduit according to the general routing indicated on the drawings reviewed and accepted by the Owner and shall coordinate conduit locations with other equipment and structures. Wherever practical, conduit shall be routed so that, except where it is changing elevation or being lowered to enter equipment, the lowest part of the conduit, including its associated supports and appurtenances, is at least 2.1metres above the closest walking surface beneath it. Conduit, including its associated supports and appurtenances, routed above work areas, walkways and platforms, shall be at least 2.1metres above the closest walking surface beneath it. It may be routed a reasonable distance away from the supporting wall of ceiling, so long as the specified support is provided, interference with other equipment and structures is avoided, and the routing is acceptable to the Owner. Conduit including its associated supports and appurtenances, which must be routed closer than 2.1metres above the closest walking surface beneath it shall be routed as close as possible to surface of walls and the equipment served. Except as otherwise specified or indicated on the drawings, all conduit shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Vertical conduit runs between platforms, shall be routed on the inside wall of the concrete chimney. Conduit which is stubbed up shall remain plugged until the conduit is extended. Conduit field routing shall be acceptable to the Owner. Routing if not acceptable, shall be rerouted and replaced without any expense to the Owner.

Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

Metal conduit shall be joined by threaded conduit couplings with the conduit ends butted. Use of running threads will not be permitted. Where metal conduit cannot be joined by standard threaded couplings, conduit unions or split couplings may be used if both material and location are acceptable to the Owner. Only ground seat type water-tight unions shall be used where the union may be submerged.

Run of conduit shall not contain more than the equivalent of four quarter bends, including those immediately at outlets or fittings. Bends in conduit



shall be made without reducing the internal diameter of the conduit. Use of a pipe tee or vise for bending conduit will not be permitted. Inside radius of conduit bends shall be not less than six times the inside diameter of the conduit. Conduits deformed or crushed in any way shall be removed from the job site.

Plane of all conduit ends shall be square with the center line. Where threads are required, they shall be cut and cleaned prior to conduit reaming. Ends of all conduits shall be reamed to remove all rough edges and burrs. Cutting oil shall be used in threading operations, the dies shall be kept sharp, and provisions shall be made for chip clearance. All steel conduit, after threading, shall be regalvanised by an acceptable galvanising process. Contractor shall supply this protective material and shall apply it in the field.

Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. Locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box.

Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulations cannot be removed by methods acceptable to the Owner, the conduit shall be replaced.

Equipment and devices which move in relation to the supply conduit due to vibration, normal operation of the mechanism, or thermal expansion shall be connected to the supply conduit using not more than 760 mm of flexible conduit adjacent to the equipment or device.

Expansion fittings shall be installed between rigidly mounted fittings in vertical raceway. Distance between expansion fittings in any individual raceway shall not exceed 15 metres.

All conduit runs shall be rigidly supported. Each conduit shall be supported within 300 mm of Junction boxes and fittings. Support spacing along conduit runs shall be as follows:

Conduit Size	Maximum Distance Between Supports
Smaller than 40 mm dia. :	1.5 metres
40 mm dia. and larger :	3 metres

Cabinets and boxes shall be rigidly mounted. Mounting on concrete shall be with bolts and expansion anchors. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both. Cabinets shall be levelled and fastened to the mounting surface with not less than 7 mm air space between the enclosure and mounting surface. All mounting holes in the enclosure shall be used. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be

centered on structures. Conduit openings in steel boxes shall be made with a hole saw or shall be punched. Cable support boxes shall be installed to be accessible from platforms.

Where supports for raceway, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with expansion shell anchors with externally split expansion shells, single cone expander and anchor break off grooved checking cones.

Contractor shall be responsible for all openings for passage of electrical raceways. Required openings not provided during chimney construction shall be provided by the Contractor using a hacksaw, a hole saw or a core drill subject to the acceptance by the Engineer-in-Charge. Opening in concrete for single conduits shall be cut by the Contractor with core drills and the conduits shall be grouted in place after being installed.

Field cutting of grating will be allowed only where specifically acceptable to the Engineer-in-Charge. Alternate routing of raceways should be used to avoid conflict with grating. If field cutting is absolutely necessary, the openings shall be made at divisions or ends of grating sections. Openings shall be square and shall be neatly finished. Rough spots shall be ground until smooth and re-galvanised as required. Openings in grating shall be sawed, not burned.

Openings that have been cut through concrete for the passage of raceways shall be finished by grouting around the conduits.

Welding shall completely fuse the welded member to the supporting steel and shall be neat in appearance. Clamps shall be used for making attachments to structural steel for installation purposes wherever possible. Welded lugs will be permitted only when specifically accepted by the Engineer-in-Charge. All temporary supports which have been welded to the structural steel shall be removed as promptly as possible. After removal, the roughened surface of the steel shall be ground smooth and a protective primer paint applied equal to that which was initially applied in the shop.

Unfinished runs of raceways shall not be used. Supports and connections for each raceway run shall be completed prior to the pull-in of any pulling line or conductor.

4.10.00 PVC Insulated FRLS Cable

a) Materials

Vol-II-B section-III of this specification shall be referred for FRLS cable. Unless specified otherwise, Contractor shall submit to the Engineer-in-Charge four copies of the manufacturer's test report on each cable furnished. Conductor accessories including terminal materials like glands, lugs etc. markers, tying materials and cable support shall be furnished and installed. Wire termination materials for conductors 10 sq.mm and larger shall be pressure or bolted type. Terminals for conductors smaller than 10 sq.mm shall be an insulated pressure connection in the shape of a ring.



b) Installation

Power and control cables shall be routed as required by the drawings. Cables pulled into the wrong conduit or cut too short shall be replaced. Cables removed from one conduit shall not be installed in another conduit.

Only lubricants recommended by the cable manufacturer and acceptable to the Owner shall be used.

Outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. Thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

Pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to indicate the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected. Extreme care shall be exercised during the installation of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. Permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations.

Cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jacket or insulation. Adequate cable end lengths shall be provided and properly installed in junction boxes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings.

Final inspection shall be made after all cables are in place and where supports and bushings deform the cable jacket, additional supports shall be provided as directed by the Owner. Additional cable protection such as a wrapping of light rubber belting, friction tape or similar material may be required. Cables in vertical runs shall be supported as indicated on the drawings.

Not less than 8 mm shall be allowed in each 15 metres vertically supported length of conductor for expansion and contraction.

Contractor shall identify the ends of all power and control circuits. He shall also identify all circuits in pull boxes. Each marker shall bear the number of the corresponding circuit according to the drawings.

Splices shall not be made in conductors.

Terminations shall be in accordance with the following requirements :

- i) Train cable in place and cut squarely to required length. Avoid sharp bends.
- ii) Remove necessary amount of cable jacket and insulation without damage to the conductor.
- iii) Install terminals or connectors as required, ensuring a firm metal-to-metal contact.
- iv) If the connection requires insulation, (i.e. cable connects to insulated conductors), apply three half- lapped layers of insulating tape over the joint, extending to two cable diameters over the cable jacket and a similar distance over any other insulation or connection requiring insulation.

Insulated conductors shall be tested after installation with a 1000 volt megger or an equivalent testing device and shall indicate approximately infinite resistance between conductors of the same circuit and between conductors and ground. Equipment and labour required for testing shall be provided by the Contractor. Any circuit failing to test satisfactorily shall be replaced or repaired and retested as directed by the Owner.

4.11.00 Earthing

a) General

Earthing system furnished and installed shall include a complete earthing system for the elevator. Earthing equipment and materials shall be furnished and installed in accordance with the reference codes and standards, these specifications, and the Contractor's shop drawings as reviewed and accepted by the Owner.

b) Materials

The earthing of all electrical items shall be supplied by the Bidder. For earthing of various equipment, conductor sizes shall be as listed below:

i)	MCCs Motors above 90 KW control panels, cable trays, etc.	:	50 x 6 sq.mm G.I.flat
ii)	Motors above 30 KW, upto 90 KW and lighting panel/ control panels/auxiliary panels	:	35 x 6 sq.mm G.I.flat
iii)	Motors above 5 KW upto 30 KW	:	25 x 3 mm G.I. flat



- iv) Motors upto 5 KW and misc.
small item like conduits,
junction boxes etc. : 8 SWG G.I. Wire

The earthing strip/wire shall be connected to the earthing mat by the Bidder provided in the chimney area. Clamps and other hardware of iron or steel used with the grounding system shall be hot-dip galvanised. Bolts, washers and nuts shall be hot-dip galvanised steel.

c) Installation

Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surface or equipment, the conductors shall run parallel or normal to dominant surfaces.

Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed one (1) metre. Damaged earth system conductors or cables shall be repaired or replaced by the Contractor as directed by the Owner.

Earth connections except equipment earthing connections shall be made by electric arc welding. Bolted connections shall be used for earthing equipment.

Earthing bushings within all enclosures, including equipment enclosure, shall be wired together and connected internally to the enclosure earthing lug at earthing bus with bare conductor.

Electrical equipment shall be earthed. Large equipment will be furnished with earthing bus. Most other equipment will be furnished with earthing pads and/or earthing lugs. Earth connection surfaces shall be cleaned immediately prior to connection. Where the earth conductor is included with the power conductors in the motor circuit raceway a compression type earth conductor termination shall be used and connected to the motor frame inside the motor terminal housing. Where the earth conductor is not included with the power conductors in the motor circuit raceway, the motor frame shall be earthed to the earth grid.

Suitable earthing facilities acceptable to the Owner shall be furnished on motors not so equipped. Earthing facilities shall consist of compression type earth conductor termination bolted to the motor frame and providing a minimum of joint resistance. Conduit system is not considered to be earthing conductor. No earthing conductor shall be smaller in size than 4 sq.mm unless it is a part of an acceptable cable assembly.

5.00.00 OPERATION AND CONTROL PHILOSOPHY

- 5.01.00 The elevators, while starting from any level, shall start at rated speed but during stopping, elevator shall slow down to lower speed when the car reaches around one meter of the selected landing floor and stop when reached the landing floor. The control system shall be through



microprocessor based AC variable voltage and variable frequency drive with remote control and wireless technology.

5.02.00 The stack elevator shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms. Bottom cage shall be rested on ground and the Bidder shall provide ladder to take entry to the elevator from ground level.

5.03.00 The stack elevator shall be attendant operated and shall not be under automatic mode of operation.

5.04.00 The operation of the elevators shall be through soft touch keys located inside the lift car. Suitable interlock shall be provided so that the elevators shall not

move unless the door is properly closed. The landing doors of any floor shall not open when the elevator is not on that floor. Soft touch keys shall be fixed in one car for holding the doors open for any length of time required.

5.05.00 The elevators under this section shall be treated as "Fire Lifts". "Fire Switch" in a glass front box shall be provided adjacent to the lifts at the entrance level, the function of which is to enable the fire authority to take over the complete control of the lifts, when required. When the switch is on, landing call points shall become inoperative and the lift shall be on the car control only. When the switch is off, the lift will return to normal working.

6.00.00 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND SITE

6.01.00 The details of the checks to be carried out in the various equipments are to be submitted by the contractor for owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the quality assurance plan to be agreed with the owner.

6.01.00 All forgings shall be subjected to ultrasonic test to ensure free from internal defects in addition to check for chemical and mechanical properties.

6.02.00 10% of the welds selected at random shall be subject to DP test.

6.03.00 All forged components shall be subjected to DPI/MPI after machining.

6.04.00 Gear Reducer shall be checked for gear ratio, backlash, and contact pattern. No load shop trial run shall be conducted on gear boxes to check for oil leakage, temperature rise, noise and vibration.

6.05.00 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.

6.06.00 All components prior to assembly shall be checked for dimensions.

6.07.00 Function test of Elevator assembly shall be carried out.

6.08.00 All electrical equipments shall be of proven quality.

6.09.00 Galvanized components/parts shall be checked for weight of Zn coating, thickness of coating, uniformity of coating and adhesion test and visual examination as per IS 2633 and IS 2629.

6.10.00 Motor shall be subject to both types and routine tests in accordance with IS-325. In addition, the following tests shall also be carried out :

- a) 20% over speed test for 2 minutes
- b) Vibration measurement
- c) Measurement of noise level as type test
- d) Degree of protection test on both motor enclosure and terminal box as per IS-4691 as type test.

6.11.00 Following items shall be tested as per relevant standard :

- a) Trailing cable
- b) Brake coil
- c) Relay contactors, instruments and controlling equipment.

6.12.00 The control panels shall conform to specific degree of protection and a type test certificate shall be submitted for Owner's approval. In absence of the same to Owner's satisfaction, the bidder shall get first panel of each type tested for specified degree of protection as per IS-2147.

Site Tests

6.13.00 After installation of complete elevator, necessary trial run and tests (No Load, ON Load, Full Load & Over load) shall be carried out by the bidder in the presence of owner to determine that the equipment supplied is satisfactorily installed and commissioned.

6.14.00 It shall also be the responsibility of the bidder to demonstrate the operation of the safety interlocks provided to the full satisfaction of the elevator inspector.

7.00.00 DRAWINGS, DATA, AND INFORMATION

7.01.00 In addition to the Proposal Data Sheets in Volume-III of this specification duly filled up, Bidder shall submit the following drawings/data/information for the elevator along with this offer.

7.02.00 Layout drawing showing principal dimensions of the elevator car in plan and the elevator car and shaft in elevation.

7.03.00 Layout drawing showing the location of various equipment in the elevator machine room.

7.04.00 Complete general arrangement drawing of the elevators and its support structure showing all landing levels and enclosures.

7.05.00 Electrical Control Schematics.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 7.06.00 Write-up, description and illustrative pamphlets on various components of the elevator and its control, interlock and safety devices.
- 7.07.00 Detailed drawing of mast including fixing details of mast sections on the chimney wall for stack elevator.
- 7.08.00 Foundation details and loading.
- 7.09.00 Load on elevator columns.
- 7.10.00 Layout of conduits, conductors, cables etc.
- 7.11.00 Other drawings, data sheets and literature as necessary.
- 7.12.00 Instruction manual for erection, testing and commissioning.





ANNEXURE-I

DATA SPECIFICATION SHEET

1.	Location of Elevator	:	Stack / Chimney						
2.	Type of Service	:	Passengers-cum-Goods						
3.	No. of Elevators (no.)	:	One (1)						
4.	Type of Elevator	:	Rack and Pinion Type, Vertical Elevator						
5.	Carrying Capacity	:	400 Kg (Minimum)						
6.	Total Height of Chimney	:	150 M						
7.	Drive Motors (AC)	:	One (1) No.						
8.	Total travel	:	150 M						
9.	Entrance	:	1 No.						
10.	Method of Control	:	Semi-Automatic						
11.	Cab floor	:	Skid Resistance Chequered Pate/GRP plywood						
12.	Cab Floor Size	:	1100 mm x1000 mm (minimum)						
13.	No of landings	:	* Minimum 5 Nos. [EL 1.2M, 40.0 M, 80.0 M, 120.0 M,135.0 M (to be finalized by the bidder during the course of detail engineering)] bidder to provide landing for all internal/external platform levels.						
14.	Operating Speed	:	40 m / min (approx.)						
15.	Power Supply	:	415V, 3 Phase, 50Hz, 4 wire(solidly grounded),dual power source arrangement shall be provided.						
16.	Roller Guides for Cage Frame:	:	At least six (6)						
17.	Other Requirements	:	<table border="0"><tr><td>1.</td><td>Plant telephone communication system shall be extended up to the elevator car.</td></tr><tr><td>2.</td><td>Suitable arrangement shall be provided to intimate unit control room during emergency in the form of audiovisual alarm.</td></tr><tr><td>3.</td><td>Automatic rescue device.</td></tr></table>	1.	Plant telephone communication system shall be extended up to the elevator car.	2.	Suitable arrangement shall be provided to intimate unit control room during emergency in the form of audiovisual alarm.	3.	Automatic rescue device.
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**Tender Specification
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18. Car Enclosure : SS construction.

Note:- 1. Top of RCC roof slab is around EL 145 M. Accordingly Bidder to check and confirm the available headroom clearance.
2. Special tools and tackles as required for the maintenance of the elevator shall be included in Contractor's scope of supply.

**ANNEXURE-II
Mandatory Spares**

Sl. No.		
1.	Bearing for Guide Roller	1Set
2.	Bearing for Counter Roller	1Set
3.	Drive Pinion	1No.
4.	Brake (EHT)	1 No.
5.	Brake Centrifugal	1 No.



**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

DOMESTIC COMPETITIVE BIDDING

Tender No: COCONTS/ 0010 K/RT/NTPL/Addl. Chimney /2020, Dt. 01.07.2020.

Date & Time of Opening: 04.08.2020 at 15.00 Hrs. (IST)

TENDER SPECIFICATION

for

**Construction of One RCC Additional Chimney of 150 M height with
Borosilicate lined Bi-flue can arrangement for Flue Gas Desulphurization
Plant of 2X500 MW Coal based Thermal Power Plant located at Tuticorin,
Tamil Nadu, India.**

VOLUME – II B SEC - III

ELECTRICAL



Development Consultants Pvt. Ltd.

July 2020



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION-III

**TECHNICAL SPECIFICATION
FOR
CHIMNEY-ELECTRICAL WORKS**



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Chimney- Electrical Works**



CONTENTS

SECTION-III

SUB-SECTION-I	:	GENERAL ELECTRICAL SPECIFICATION
SUB-SECTION-II	:	A.C. MOTORS
SUB-SECTION-III	:	POWER DISTRIBUTION BOARD
SUB-SECTION-IV	:	ILLUMINATION
SUB-SECTION-V	:	CABLES
~~SUB-SECTION-VI~~	~~:~~	~~UPS~~
SUB-SECTION-VII	:	GROUNDING AND LIGHTNING PROTECTION
SUB-SECTION-VIII	:	ERECTION





CONTENTS

SECTION-III

SUB-SECTION-I

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GENERAL REQUIREMENT	1
2.00.00	SCOPE OF SUPPLY & WORK	6
3.00.00	INTERFACING WITH OWNER/PHASE-III PACKAGE VENDOR	7
4.00.00	LAYOUT CRITERIA	8
5.00.00	MOTORS	8
6.00.00	DISTRIBUTION BOARDS	8
7.00.00	DAY MARKING	8
8.00.00	ILLUMINATION	9
9.00.00	CABLES AND CONDUITS	9
10.00.00	GROUNDING AND LIGHTNING PROTECTION	9
11.00.00	TESTS	10
12.00.00	GUARANTEE	10
13.00.00	DRAWINGS, DATA AND MANUALS	10

ATTACHMENTS

ANNEXURE-A	MANDATORY SPARE PARTS	11
ANNEXURE-B	LIST OF DRAWINGS	12





VOLUME: II-B

SECTION-III

SUB-SECTION-I

GENERAL ELECTRICAL SPECIFICATION

1.00.00 GENERAL REQUIREMENT

1.01.00 General

1.01.01 Bidder shall provide fully compatible electrical system, equipment, accessories and services for the entire Chimney in his scope as well as those specifically required by the Owner.

1.01.02 All equipment, material and systems shall conform to the latest edition of relevant National and International Codes & Standards, in particular the Indian Statutory Regulations.

1.01.03 Drawings and annexure appended to this specification shall form part of this specification and supplement the requirements specified herein. This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points.

1.01.04 It is not the intent to specify completely herein all details of the system or equipment. Nevertheless, the system/equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship.

1.01.05 Any system, material or accessory which may not have been specifically mentioned but which are necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any commercial implication to the Owner.

1.01.06 Proposal Data Sheets

The Proposal Data Sheets annexed to this specification shall be filled in without any ambiguity by typing in appropriate place on each page. These pages must be properly signed by authorized representative of the Bidder as verification of the data and submitted along with the bid to form part of the Bidder's formal proposal.

1.01.07 Performance Guarantee

The performance figures quoted in Technical Particular Sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection at any stage.

1.01.08 Deviation





Should the Bidder wish to deviate from this specification in any way, he shall draw specific attention to such deviation. All such deviations shall be clearly

mentioned on the Deviation sheet, with reference to the respective clause of the specification. Unless such deviations are recorded in the Deviation sheets and submitted with the offer, it shall be taken for granted that the offer is made in conformity with this specification in all respects.

1.01.09 **Drawing Approval**

Before starting manufacture of any equipment, the Bidder shall have to take approval of relevant drawings and data from Engineer in writing. Any manufacture done prior to the approval of drawings/data shall be rectified in accordance with the approved drawings/data by the Bidder at his own cost and the equipment shall be supplied within the stipulated period.

1.01.10 **Site Condition**

Refer Vol IIA of Lead specification.

1.01.11 **Co-Ordination with Statutory Bodies and Outside Agencies**

The Bidder shall be fully responsible for carrying out all co- ordination and liaison works with Electrical Inspectors, Factory Inspector, and other statutory bodies for implementation of the work.

Applications on behalf of the Owner, for submission to the Electrical Inspector and other statutory bodies along with necessary drawings complete in all respects shall be prepared by the Bidder. Approved drawings and certificates shall be submitted to the Owner/Consultant well ahead of schedule so that the actual commissioning of equipment does not get delayed for want of inspection and approval by the Inspector and other statutory bodies. The actual inspection work by the Electrical Inspector shall be arranged by the Bidder and necessary coordination and liaison work in this regard shall be the responsibility of the Bidder.

1.02.00 **Codes & Standards**

1.02.01 **Equipment**

All electrical equipment and materials shall conform to latest applicable standard publications of International Electro technical Commission (IEC) or equivalent standards published by the Bureau of Indian Standards (BIS) and other standards mentioned in the various volumes of sections of this specification. In case of a conflict between IEC and other standards, the requirement of IEC shall govern. The provisions of tender specifications (except the clause of codes and standards of individual specification) shall however have precedence over all other standards.



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

1.02.03 **Installation**

All electrical installation work shall comply with the provisions of the Indian Electricity Act, the Indian Electricity Rules as amended up to date, relevant IS Codes of Practice and recommendations of the Tariff Advisory Committee (TAC). In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rules shall be binding.

Nothing in this specification shall be construed to relieve the Bidder of his responsibility to abide by the Standards or Codes.

1.03.00 **Auxiliary Voltages**

1.03.01 Auxiliary AC voltage supply arrangement shall have 415V system. It shall be designed to limit voltage variations as given below under worst operating condition:

- LT AC System - $\pm 10\%$

1.03.02 Following auxiliary voltages will be envisaged for LT auxiliary power, control and instrumentation.

- 240 V $\pm 10\%$, 1 Ph, 50 Hz +3% to -5%

1.04.00 **Scheme For Auxiliary Power Distribution**

1.04.01 Power distribution diagram of Chimney as shown in the attached **Dwg. No.18A09-CHM-DWG-E-0002** is for Bidder's compliance. To supply power to elevator, different receptacles, lighting panels etc. a 415V main power distribution board (MPDB) and one (1) no. Emergency Power Distribution Board (EPDB) shall be provided by the Bidder.

Two (2) numbers incoming feeders, adequately rated, to this MPDB will be taken by Chimney Package vendor from FGD PMCC, rated 415V $\pm 10\%$, 3 phase, 4 wire, 50 Hz $\pm 5\%$ (fault level 50 KA for 1 sec).

1.04.02 One (1) no. 415V Emergency power distribution board (EPDB) shall be provided by the Bidder. One (1) number emergency power supply feeder to the EPDB shall be arranged by Chimney Package vendor from FGD Emergency switchboard, rated 415 V $\pm 10\%$, 3 phase, 4 wires, 50 Hz $\pm 5\%$ (fault level 50 KA for 1 sec)

1.04.03 Supply, laying, termination and connection of the cabling system and overhead racks /cable trestle etc. between FGD plant switchboard to Chimney switchboard (i.e MPDB & EPDB) shall be included under bidder scope with necessary interfacing with FGD package bidder.





1.04.04 Any other, supply voltage, if required for electrical system of Chimney shall be arranged by the Bidder through suitable means as necessary. Portable type UPS shall be used for supplying UPS power to different type of Analyzer equipment / panel, data logger etc.

1.05.00 **Motor Voltage**

The voltage level for motors shall be as follows:

- a) 415 Volt, 3 Phase, 50 Hz : $0.2 \text{ kW} < \text{Motor kW} \leq 160 \text{ kW}$
- b) 240 Volt, 1 Phase, 50 Hz : $\text{Motor kW} \leq 0.2 \text{ kW}$

1.06.00 **Enclosure Protection**

Degree of protection of enclosures as per IS: 13947 shall be as follows:

Sl. No.	Item	Degree of Protection
1	415V MCC / DBs / Fuse Board	IP52 for indoor and IP65 for outdoor
2	Motor (Indoor/Outdoor)	IP55
3	Motor Actuator	IP65
4a	Pushbutton Station/Kiosk/Panel - Indoor	IP55
4b	Pushbutton Station/Kiosk/Panel - Outdoor	IP65
5	Indoor Junction boxes for cables / wires	IP55
6	Outdoor lighting fixtures	IPW65

1.07.00 **Painting For Electrical Equipment**

Epoxy based with suitable additives. The thickness of finish coat shall be minimum 80 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 80 microns shall be acceptable for finish coat.

1.08.00 **Quality Assurance**

1.08.01 The Bidder shall follow his standard procedures for quality assurance and control. A copy of the said standard procedures shall be submitted to the Owner / Purchaser for his reference. However, Owner / Purchaser reserve the right to review the same and give his observations, if any, for compliance.

1.08.02 The Owner / Purchaser shall inform the Bidder as to which of the inspection points and tests shall be witnessed. As a minimum, inspection and testing of





the finished equipment shall be made prior to shipment, unless specifically waived by the Owner / Purchaser. The Bidder shall give at least fifteen (15) days advance notice regarding readiness of the equipment.

- 1.08.03 The Owner / Purchaser may conduct surveillance of the Bidder's facilities for compliance to his standard procedures of Quality Assurance and Quality Control while work on the specified equipment is in progress.

1.09.00 **Drawings / documents for Approval**

- 1.09.01 The Bidder shall submit his Master Deliverable Schedule considering the priority of the listed documents with respect to the project execution schedule. The document in the schedule should be marked in two categories viz. (a) 'For Approval' (A) and (b) 'For Reference' (R).

- 1.09.02 The Bidder shall submit document in sequential format i.e. the basic engineering documents in 'For Approval' category and obtain approval of those documents prior to submittal of corresponding detail engineering documents. For the Bidder's guidance - such documents shall include, but not limited to the following:

I.> Approval Category

- a) Master Deliverable List – Electrical with schedule of submission
- b) Design basis report for various equipment/system like :-
 - Design Memorandum - Grounding system
 - Design Memorandum – Lightning protection system
 - Design Memorandum – Illumination system
- c) Power distribution diagram indicating rating of equipment
- d) Sizing Calculation of various electrical equipment/system like –
 - Cables
 - lightning protection
- e) Layout drawings like :
 - Electrical equipment layout of electrical room
 - Cable tray & trestle layout
 - Illumination layout
 - Earthing layout
 - Lightning protection
- g) All drawings/data relevant to the equipment like QAP, Guaranteed Technical Particulars, General Arrangement Drawing etc.

II.> Information Category

- a) Dimensional General arrangement drawing along with cross-sections for equipment
- b) Bill of material
- c) Wiring diagram
- d) Cable schedule & interconnection chart
- e) Cable numbering scheme
- f) Any other drawings & data as required etc.

- 1.09.03 The Owner's Consultants may review a document assigned in 'For Reference' category as they deem necessary and furnish comments for compliance by the Bidder.





2.00.00 SCOPE OF SUPPLY & WORK

2.01.01 The scope of work related to electrical system is an intrinsic part of the total EPC Contract. The Bidder's scope shall include but not limited to the complete detail design and engineering of electrical works related to power distribution, illumination including aviation obstruction lighting, cabling, grounding, lightning protection, construction, installation, testing and putting into successful commercial operation of the Chimney electrical system.

2.01.02 Scope of work shall also cover the design, manufacture, assembly, testing at manufacturer's works/laboratory, supply, delivery including insurance, properly packed for transport to site, storing at site of all equipment, material and accessories related to above electrical work as detailed hereinafter in this specification.

2.01.03 The work is subject to all the terms and conditions detailed in the documents listed below, which shall form part of this specification as if bound together.

- a) Tender Notice
- b) Instruction to Bidders
- c) General conditions of contract for supply, delivery & installation of plant and materials.

2.01.04 In the event of any discrepancy with listed documents, the stipulation of this specification shall govern.

2.02.00 Scope of Supply

2.02.01 The work involves timely procurement and transportation to site in properly packed condition of all equipment, materials and miscellaneous items required to complete the project.

2.02.02 The scope of supply and services shall include but not be limited to the following for Chimney:

- a) All equipment and materials as indicated under clause no. 2.02.03 & as required.
- b) Mandatory spare parts.
- c) Recommended spare parts for three (3) years operation

2.02.03 Chimney shall be provided with but not limited to the following:

- a) Normal and Emergency Power distribution board and control system
- b) Electrical system for Elevator
- c) Aviation Obstruction Lighting system





- d) Illumination system including complete Aviation lighting (temporary & permanent) and street/area lighting.
- e) Power & Control cables
- f) Cabling, grounding and lightning protection system
- g) All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary.
- h) DC facilities are not envisaged. However, if any DC power requirement is needed by the Bidder the same has to be included in the bidder's scope.

2.03.00

Scope of Services

The scope of services shall include detail design for construction and installation of entire electrical system of Chimney Package.

- All cable trays, cable supports, galvanized steel conduits etc. from top to the bottom of Chimney and to MPDB, from FGD emergency board (to be located at FGD Plant electrical room) to EPDB at Chimney and routing of all cables.
- Grounding and lightning protection system including underground grounding mat, over ground grounding grid, air terminal network and connection with main ground grid.
- Illumination system of Chimney and surrounding areas including point wiring with PVC wires in conduits, aviation obstruction light, receptacles and power socket outlets.

Illumination layouts showing dispositions of fixtures, conduit routing.

- Preparation of installation, commissioning, operation and maintenance manuals.
- Obtaining statutory approvals for Aviation warning system from concerned authority.
- Necessary interfacing with FGD Package Vendor is included under Bidder's scope.

3.00.00

INTERFACING WITH OWNER/FGD PACKAGE VENDOR

3.00.01

Power supply to MPDB and EPDB for Chimney shall be as described under clause no.-1.04.00. Bidder to ensure and indicate the exact power requirement accordingly.





- 3.00.02 Cable Trays, Trestle etc. as required for complete cabling system with necessary hardwires etc. is included under Bidder's scope.
- 3.00.03 Chimney grounding system (both below & above ground), earthing of electrical equipment and lightning protection system is included under Bidder's scope. Bidder shall connect below ground earthing with FGD package earthing minimum at two different points.
- 3.00.04 MPDB, EPDB, Normal Lighting Panels (NLP), Emergency Lighting Panels (ELP) etc. (as required) for Chimney electrical works will be located at ground floor of Chimney.
- 3.00.05 Necessary interfacing with Other Package Vendor/Owner is included under Bidder's scope.

4.00.00 LAYOUT CRITERIA

For finalizing location of Electrical DB's, following minimum requirement shall be complied:

- 4.01.00 Minimum clearance of 800 mm shall be provided on rear of panel for single front boards where rear door width is less than 800 mm. Generally cable trench below any electrical switchboard shall be of adequate width to allow easy approach to panel bottom from rear of panels.
- 4.02.00 In general clearance of 1000 mm will be maintained on rear of single front panels.
- 4.03.00 Clearance between adjacent panels in a row shall be less than 200 mm or more than 800 mm. This clearance shall also be guided by equipment handling space where applicable and space required for movement of personnel.
- 4.04.00 Clearances in between adjacent panels in a row or from the side wall/door shall be so decided that handling of shipping section of any board is not obstructed.

5.00.00 MOTORS

Refer sub-section-II of Volume-IIB.

6.00.00 POWER DISTRIBUTION BOARDS

Refer sub-section-III of Volume-IIB.

7.00.00 DAY MARKING

The external surface of the chimney shall be painted with horizontal strips of 2.5 M wide alternate bands of aviation red and aviation white paint. Quality paint and materials shall be selected, subject to Consultant's approval, to





provide extra years of service. The paint shall be compatible with surfaces to be painted, including any previous coatings, and suitable for the environmental conditions. Surface preparation and paint application shall be in accordance with manufacturer's recommendation.

8.00.00 ILLUMINATION

Refer sub-section-IV of Volume-IIB.

9.00.00 CABLES AND CONDUITS

9.01.00 Power & Control cable shall be as per sub-section-V of Volume-IIB.

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

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

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

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

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

9.06.00 Conduits shall be hot dip galvanized conforming to relevant IS/IEC.

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

10.00.00 GROUNDING and LIGHTNING PROTECTION

Refer sub-section-VI of Volume-IIB.





11.00.00 TESTS

The bidder shall carry out all tests (type as well as routine test) as per relevant IS (Indian standard) for electrical equipment. The tests shall be carried out in presence of Owner's representative, for which minimum fifteen (15) days notice shall be given by the bidder. The bidder shall obtain owner's approval for the test procedure prior to performance of tests. The test procedure shall specify test set-up, instruments to be used, acceptance norms, recording of various parameters, interval of recording, precautions to be taken etc. In addition, any special test if required shall also be performed.

Type test certificate not more than 5 years old shall be furnished for approval.

12.00.00 GUARANTEE

In the installation if any trouble arises due to the use of defective or faulty material and/or bad workmanship within a period of 12 months from the date of taking over, the Bidder shall guarantee to replace or repair the defective part(s) at site to the entire satisfaction of the Owner's Engineer free of charge.

13.00.00 DRAWINGS, DATA AND MANUALS

- 13.01.00 To be submitted with the Bid
- 13.01.01 Power requirement for Chimney.
- 13.01.02 Typical general arrangement drawing of Chimney showing location of lighting fixtures, lightning protection system, grounding system etc.
- 13.01.03 Typical general arrangement drawing of main power distribution board, Emergency power distribution board etc.
- 13.01.04 Catalogue cuts of various types of lightning fixtures, major components, cables, conduits etc.
- 13.01.05 Type Test Certificate of various equipment.

ANNEXURE - A

MANDATORY SPARE PARTS

Sl. No.	Item	Qty.
1	Medium intensity red flashing light	3 Nos.
2	Low intensity steady light	3 Nos.
3	Control Unit for aviation warning light	2 Nos.
4	Lighting transformer	1 No.
5	M.C.C.B.	One (1) of each type and rating
6	M.C.B.	Five (5) of each type and rating
7	Motor	One (1) of each type and rating
8	Push Button	Two (2) of each type and rating
9	Contactors	One (1) of each type and rating
10	Receptacles	One (1) of each type and rating



ANNEXURE – B

LIST OF DRAWINGS

Sl. No.	DRAWING NOS.	DESCRIPTION
1	18A09-CHM-DWG-E-0002	POWER DISTRIBUTION DIAGRAM OF CHIMNEY
3	18A09-DWG-E-0400	CABLING NOTES & DETAILS
4	18A09-DWG-E-0600	GROUNDING NOTES AND DETAILS
5	18A09-DWG-E-0800	ILLUMINATION NOTES AND DETAILS
6	18A09-DWG-E-1000	LIGHTNING PROTECTION NOTES AND DETAILS



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-B
SECTION-III
SUB-SECTION-II
TECHNICAL SPECIFICATION
A.C. MOTORS**



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-II
A.C. Motors**



**Tender Specification
for
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**NLC Tamil Nadu Power Ltd.
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Tuticorin, Tamil Nadu**

CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	TYPE	1
2.00.00	PERFORMANCE	1
3.00.00	SPECIFIC REQUIREMENTS	3
4.00.00	ACCESSORIES	5
5.00.00	TESTS	6
 ATTACHMENT		
ANNEXURE-A	DESIGN DATA	8





VOLUME: II-B

SECTION-III

SUB-SECTION-II

A.C. MOTORS

1.00.00TYPE

1.01.0 A.C. Motors

- 1.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.
- 1.01.02 The motor shall be self-ventilated type, with TEFC / TETV cooling, depending on requirement and rating.
- 1.01.03 All motors shall be rated for continuous duty (S1). They shall also be suitable for long period of inactivity.
- 1.01.04 All LT motor shall conform to minimum efficiency performance standards (MEPS) of IE3 mentioned in IS: 12615..
- 1.01.05 The motor name plate rating at 50°C shall have at least 15% margin for LT system, over the input power requirement of the driven equipment at rated duty point and also covering the maximum load demand of the driven equipment under entire operating range, including voltage and frequency variations, unless stated otherwise in driven equipment specification or in general electrical specification.
- 1.01.06 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service. The direction of rotation of motor and its cooling fan should be properly matched with the driven equipment.

2.00.00 PERFORMANCE

2.01.00 Running Requirements

- 2.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.
- 2.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

2.02.00 Starting Requirements





- 2.02.01 For LT motors the starting current shall be as per the limit mentioned in the relevant standard with IE-3 efficiency class. For D.C. Motors the starting current shall be limited to 2 times full load current.
- 2.02.02 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- 2.02.03 All motors (except mill motors) shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals without exceeding acceptable winding temperature.
- 2.02.04 Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition.
- 2.02.05 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.
- 2.02.06 Motors subjected to bus transfer shall be suitable for sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.
- 2.02.07 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.
- 2.03.00 **Locked Rotor Withstand Time**
- 2.03.01 For motors with starting time up to 20 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 2.5 secs.
- For motors with starting time more than 20 secs. and upto 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 5 secs.
- For motors with starting time more than 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 10% of the starting time.
- 2.03.02 To prevent unwanted tripping of a high inertia load at start-up, there may be need to shunt out the motor's overload trip device. Speed switches mounted on the motor shaft may be provided in such case. Heating experienced during start-up must still be considered when sizing the motor.
- 2.03.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

2.04.00 Torque Requirements

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

2.04.02 Pull out torque at rated voltage shall not be less than 205% of full load torque.

3.00.00 SPECIFIC REQUIREMENTS

3.01.00 Enclosure

3.01.01 All motor enclosures and terminal boxes shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction. Separate Canopy shall be provided for LT motors located in outdoor or semi-outdoor area.

Motors, located inside a building and not directly exposed to coal dust or fly ash, could have screen protected drip proof enclosure conforming to IP-23.

3.01.02 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv.

3.02.00 Winding and Insulation

3.02.01 All insulated winding shall be of copper. Windings shall be impregnated to make them non-hygroscopic, flame resistant and oil resistant. The lightning impulse and coil inter-turn insulation surge withstand level shall be as per IEC-60034 – Part 15.

3.02.02 Motors shall have Class F or higher insulation with temperature rise limited to 120°C.

3.03.00 Tropical Protection

3.03.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

3.03.02 All fittings and hardwares shall be corrosion resistant.

3.04.00 Bearings

3.04.01 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application.

3.04.02 Vertical shaft motors shall be provided with thrust and guide bearings.

3.05.00 Noise & Vibration

3.05.01 The noise level shall not exceed 85 db (A) at 1.0 meters from the motor.



3.05.02 Peak amplitude of vibration shall be limited within the values prescribed in IS: 12075 / IEC 60034-14.

3.06.00 Motor Terminal Box

3.06.01 Motor terminal box shall be detachable type, made of cast iron or pressed steel and located in accordance with Indian Standards clearing the motor base-plate / foundation.

3.06.02 Terminal box shall be capable of being turned 360 Deg. in steps of 90 Deg., unless otherwise approved.

3.06.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor. Terminal box for all LT motors shall be diagonally split type.

3.06.04 The terminal box shall have sufficient space inside for termination / connection of XLPE (415V) insulated armoured aluminium cables. Where the specified main cable size demands, adopter / extension box of suitable size shall be provided as a part integral to the motor, for easy termination of the cable.

3.06.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

3.06.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

3.06.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.06.08 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

3.06.09 The gland plate for single core cable shall be non-magnetic type.

3.07.00 Grounding

3.07.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

3.07.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:

Motor above 90KW	:	50 x 6 mm GS Flat
Motor above 30KW up to 90KW	:	35 x 6 mm GS Flat
Motor above 5KW up to 30KW	:	25 x 3 mm GS Flat
Motor up to 5KW	:	8 SWG GI Wire



3.07.03 The cable terminal box shall have a separate grounding pad.

3.08.00 **Rating Plate**

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate:

- a) Temperature rise in Deg.C under rated condition and method of measurement.
- b) Degree of protection (IP No.).
- c) Bearing identification no. and recommended lubricant.
- d) Location of insulated bearings.

4.00.00 **ACCESSORIES**

4.01.00 **General**

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

4.02.00 **Space Heater**

4.02.01 Motor of rating 30KW and above shall be provided with space heaters, suitably located for easy removal or replacement.

4.02.02 The space heater shall be rated 240V, 1 phase 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

4.03.00 **Accessory Terminal Box**

4.03.01 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit required cable connections.

4.04.00 **Drain Plug**

Motor shall have drain plugs so located that they shall drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

4.05.00 **Lifting Provisions**

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

4.06.00 **Dowel Pins**

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

4.07.00 Painting

Motor including fan shall be painted with corrosion proof paints.

5.00.00 TESTS

5.01.00 Upon completion, each motor shall be subject to standard routine tests as per IS. In addition, any special test called for in the driven equipment specification shall be performed.

5.02.00 Unless and otherwise stated, Six (6) copies of routine test certificates shall be submitted for approval prior to the dispatch of the motors from works.

5.03.00 The following type test reports shall be submitted for each type and rating of 11 kV & 3.3 kV motor:

- a) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- b) Fault level withstand test for each type of terminal box.
- c) Lightning impulse withstand test on the sample coil as per IEC 60034, part-15.
- d) Surge withstand test on inter-turn insulation as per clause no. 5.1.2 of IEC 60034, part-15.

5.04.00 SPARES

Recommended spares for three (3) years operation shall be quoted along with the bid clearly identifying the part numbers with recommended quantities.

06.00.00 DRAWINGS, DATA & MANUALS

Drawings, data & manuals for the motors shall be submitted as indicated below:

06.01.00 Along with the bid

- a) List of the motors
- b) Individual motor data sheet as per format of the proposal data sheets.
- c) Scheme & write up on forced lubrication system, if any
- d) Type test report



06.02.00 After Award of the Contract

- a) Dimensional General Arrangement drawing
- b) Foundation Plan & Loading
- c) Cable end box details
- d) Space requirement for rotor removal
- e) Thermal withstand curves hot & cold
- f) Starting and speed torque characteristics at 80% & 100% voltage
- g) Complete motor data
- h) Erection & Maintenance Manual
- i) Efficiency curves.
- j) List of motors.
- k) Test reports



ANNEXURE – A

1.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
L.T. Supply	415V, 3 ϕ /, 3W, 50 Hz Effectively earthed Fault level 50 KA sym. for 1 seconds.	Motors above 200W upto 160 kW
	240V, 1 ϕ /, 2W, 50 Hz Effectively earthed	Motors below 200W Lighting, space heating, A.C. control protective devices

2.0 RANGE OF VARIATION

A.C. Supply

Voltage	:	$\pm 10\%$
Frequency	:	$\pm 5\%$
Combined Volt & frequency	:	10% (absolute sum)



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION-III

SUB-SECTION-III

TECHNICAL SPECIFICATION

POWER DISTRIBUTION BOARD



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-III
Power Distribution Board**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE OF SUPPLY	1
2.00.00	GENERAL NOTES	1
3.00.00	SYSTEM CONCEPT AND DESIGN CRITERIA	1
4.00.00	SPECIFIC REQUIREMENTS	2
5.00.00	TESTS	5





VOLUME: II-B
SECTION-III
SUB-SECTION-III

POWER DISTRIBUTION BOARD

1.00.00 SCOPE OF SUPPLY

1.01.00 The following equipment shall be furnished complete with all accessories:

- a) Main Power Distribution Board (MPDB) : One (1)
no.
- b) Emergency Power Distribution Board (EPDB) : One (1)
nos.

1.02.00 Base channel frame of all boards along with necessary mounting hardware.

1.03.00 Mandatory spares.

1.04.00 All relevant drawings, data and instruction manuals.

2.00.00 GENERAL NOTES

2.01.00 MPDB shall feed power to Elevators, Lighting Distribution Board (LDB), Emergency Distribution Board, Power Receptacles and other load requirement.

2.02.00 Emergency Power Distribution Board (EPDB) shall feed power to Aviation Lighting Panel (ALP) & Emergency Lighting Panel.

3.00.00 SYSTEM CONCEPT AND DESIGN CRITERIA

3.01.00 MPDB shall supply auxiliary power for normal operation.

3.02.00 The equipment will be located in a hot, humid, and tropical atmosphere, heavily polluted.

3.03.00 Busbars of DBs shall be sized to carry continuously the total running load of the DB (including anticipated future load, wherever applicable) plus a 20% margin.

3.04.00 In-cubicle ratings of incomer and bus-section breakers shall be identical to the associated busbar rating.





- 3.05.00 Incomers rated up to and including 400A shall be MCCB/ switch controlled. Above 400A, all incomers and feeders shall be breaker controlled.
- 3.06.00 20% spare feeders with minimum one (1) no. of each type and rating shall be provided.
- 3.07.00 MPDB & EPDB shall be provided with an adequately rated dry type, delta/star, transformer with Dyn11, $\pm 2 \times 2.5\%$ Tap, 415V / 415V. The star point of the secondary side shall be solidly grounded to get 3 phases, 4 wire supplies.

The dry type transformer shall have the following properties:

Type	: Cast Resin Dry Type
Voltage rating	: 415/415V
Cooling	: AN
Impedance	: As per IS
Voltage Control	: Off load
Class of Insulation	: F
Temperature rise over 50° C ambient	: 70° C
Neutral	: Solidly Grounded
Mounting	: Inside main Lighting Distribution Board

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Construction

- 4.01.01 DBs shall be indoor, air insulated, and metal-clad type. The design construction shall be such as to permit extension at either end.
- 4.01.02 DBs shall be floor-mounting type & Single front construction.
- 4.01.03 All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2mm.
- Frame shall be enclosed in cold rolled sheet steel of thickness not less than 2mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Removable gland plates of thickness 3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels.





- 4.01.04 DBs shall be fully compartmentalized with metal/ insulating partitions between compartments. Working height shall be limited between 450mm and 1800mm from floor level.
- 4.01.05 All doors and covers shall be neoprene gasketed.
- 4.01.06 For DB modules, all push-buttons, lamps, and indicating instruments shall be flush/semi-flush mounted on respective module compartment.
- 4.01.07 Four (4) Nos. lifting lugs shall be provided for each section, two (2) nos. on either end of the section.
- 4.01.08 The minimum clearance in air between phases and between phases and earth for the entire run of horizontal and vertical busbars shall be 25mm. For all other components, the clearance between two live parts, a live part and an earthed part, and isolating distance shall be at least 10mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by barriers. However, for horizontal and vertical busbars, the clearances mentioned above should be maintained even when these are sleeved or insulated. All connections from busbars shall be fully shrouded to minimize the risk of phase to phase and phase to earth shorts.
- 4.02.00 **Bus and Bus Taps**
- 4.02.01 All busbar compartments shall be completely enclosed. Horizontal and vertical busbars and bus connections shall be of high conductivity Aluminium/ Aluminium alloy.
- The maximum temperature of busbars and bus connections shall be limited to 55°C with silver plated joints and 40°C with all other types of joints over an ambient of 50°C.
- No diversity factor shall be allowed for temperature rise.
- 4.02.02 Vertical busbars shall be designed for a minimum current rating of 200 A.
- 4.02.03 All bus connections shall be provided with anti-oxide grease. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.
- 4.02.04 Bimetallic connectors shall be provided for connections between dissimilar metals.
- 4.02.05 All busbars and bus connections shall be fully insulated for working voltage. Insulating heat shrinkable sleeves shall be provided for all busbars. All joints and tap-off points shall be shrouded.
- 4.02.06 Bus insulators shall be non-hygroscopic, flame retardant, track resistant, high strength, sheet molded compound or equivalent polyester fibreglass molded type. Separate supports shall be provided for each phase and neutral busbar.



- 4.02.07 Cross-section of the busbars shall be uniform throughout the length of the assembly. All busbars and bus connections shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.
- 4.02.08 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left-to-right, top-to-bottom, or front to rear when viewed from the front of the assembly.
- 4.02.09 Bolted disconnecting links shall be provided for all incoming and outgoing feeders for isolation of neutral, if necessary.
- 4.03.00 **Terminal Blocks**
- 4.03.01 Terminal blocks shall be 1100V grade box-clamp type 10-mm² minimum with marking strips.
- 4.03.02 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished and these spare terminals shall be uniformly distributed on each terminal blocks.
- 4.04.00 **Cable Termination**
- 4.04.01 Generally, all assemblies shall be designed for cable entry from the bottom. Sufficient space shall be provided for all the cables as per cable schedule, for ease of termination and connection.
- 4.05.00 **Ground Bus**
- 4.05.01 A ground bus, rated to carry maximum fault current, shall be provided which shall extend the full length of the assembly.
- 4.05.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts and nuts at each end and shall be suitable to receive 50 x 6 mm G.S. flat.
- 4.06.00 **Nameplates**
- 4.06.01 Nameplates of approved design shall be provided on each cubicle, at the top of the assembly and on each instrument & device mounted on or inside the cubicle.
- 4.06.02 The material shall be lamicoid or approved equal. 3 mm thick with white letters on black background.
- 4.07.00 **Tropical Protection**
- 4.07.01 All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.
- 4.08.00 **Moulded Case Circuit Breaker (MCCB)**
- 4.08.01 Moulded Case Circuit Breaker (MCCB) shall be three pole, single throw, air break type having trip free mechanism with quick make, quick break contacts.



MCCB shall have current limiting design.

MCCB of identical rating shall be physically and electrically interchangeable.

Each MCCB shall be provided with 1 NO and 1 NC electrically separate auxiliary contacts.

4.08.02 MCCB for motor feeders shall have adjustable short circuit release. MCCB used for 50KW and above motor rating shall have additional E/F protection.

4.09.00 **Miniature Circuit Breaker (MCB)**

4.09.01 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

4.10.00 **Painting**

4.10.01 All assemblies shall be finished in light grey (IS shade * 631) with two coats of synthetic enamel paint. Painting process shall be of powder coating type.

5.00.00 TESTS

5.01.00 The item shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-B
SECTION-III
SUB-SECTION-IV
TECHNICAL SPECIFICATION
ILLUMINATION**



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-IV
Illumination**



CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE OF SUPPLY	1
2.00.00	SYSTEM CONCEPT	2
3.00.00	RATINGS & REQUIREMENTS	5
4.00.00	SPECIFIC REQUIREMENTS	6

ATTACHMENTS

ANNEXURE-A	AVAILABLE POWER SUPPLY	11
ANNEXURE-B	AVERAGE LUX LEVEL OF DIFFERENT AREAS	12
ANNEXURE-C	TYPES OF FITTINGS/ FIXTURES AND OTHER AUXILIARIES	13





VOLUME: II-B
SECTION-III
SUB-SECTION-IV
ILLUMINATION SYSTEM

1.00.00 SCOPE OF SUPPLY

- 1.01.00 The work involves timely procurement and transportation to site in properly packed condition of all equipment, materials and miscellaneous items required to complete the project.
- 1.02.00 The equipment and materials within the scope of supply shall include but not limited to:
- a) Lamp and LED type lighting fixtures and related LED accessories.
 - b) Lighting panels/ boards: All panels shall be provided with energy saving system.
 - c) Street light poles.
 - d) Receptacles, switches, switchboards, portable emergency lights etc.
 - e) Cables, wires, splicing/termination/connection accessories including 4 way/3 way/2 way cable junction boxes with disconnecting devices on each way.
 - f) Conduit and accessories, junction and pull boxes, terminal blocks.
 - g) Grounding materials and connections.
 - h) All fittings, supports, brackets, anchors, clamps and connections.
 - i) Steel for field fabrication of supports and brackets.
- 1.03.00 Carrying out of detail engineering, including detail design calculations, preparation of lighting layouts showing location of fixtures, cable, wires conduit routing, indicating number and size of wires in each conduit and preparation of cable schedule and other related drawings as detailed in subsequent clauses consider the energy saving and energy efficient illumination system.
- 1.04.00 Preparation of "As built" drawings at the option of owner.
- 1.05.00 Special tools and tackle.





2.00.00 SYSTEM CONCEPT

2.01.00 Aviation Warning Lights

2.01.01 In accordance with ICAO regulations and Director General of civil aviation India requirements, aviation warning lights are required to be provided at various levels of Chimney along its perimeter. Suitable photo-electric sensors, alarm and annunciation systems, etc. shall also be provided along with the required auxiliaries for completing the system in all respects.

2.01.02 The number of obstruction lights to be installed at specified level shall be such that the obstruction is indicated from every angle in the azimuth. Fixtures on each level shall be arranged at the same elevation and with equal radial spacing around the Chimney. The life of AOLs shall be more than 10 years and shall have corrosion resistant aluminum casting finished in stove enameled control gear suitable for 200/240V, 50Hz supply, complete with all accessories.

2.01.03 The AOL system shall be provided with Photoelectric light detectors to monitor north sky for controlling the aviation warning lights. The lights should not be switched off for momentary increases in light intensities due to lightning flashes or any other short bursts of light. The detectors should be complete with all the accessories, hardware etc. necessary for installation. The facility for Auto/Manual operation shall be provided. AOL distribution board shall be fed from emergency power distribution board (EPDB).

2.01.04 The aviation warning lights shall be high power light emitting diodes (LED) and to be installed on Chimney shall be as follows:

- Medium intensity (>1600 cd) red flashing lights (20-60 flashes per minute- adjustable) above height of 61 M upto 150M.
- Low intensity (>10 cd) steady lights below 61 M

The top most lights shall be placed between 3M to 5M below the top of Chimney and the rest at each platform level. The lights shall be spaced equally with minimum four (4) numbers around the Chimney.

2.01.05 The aviation warning lights shall be adequately secured to the Chimney against wind forces and shall be mounted so that they are accessible for lamp replacement and cleaning.

2.01.06 The lighting system shall be energized through an adjustable timer (0-24 hrs.). The timer shall cause the control unit to energize and de-energize the aviation lighting system automatically as per the preset time. In addition auto-manual selection with manual ON-OFF facility of the lights shall be provided in the control unit.

2.01.07 LED lamps should be maintenance free long life LEDs (Having a life of



1000,000 hours or more at the rate of 12 hours burning per night).

- 2.01.08 Since the LEDs have a directional light intensity and individual LEDs of high intensity have not been developed, the bidder has to use a columnar array of LEDs, such column being placed in a circular configuration, each column totaling the minimum intensity requirement at all times during its life. Bidder has to guarantee the same.
- 2.01.09 All the Luminaries should have IP 65 protection.
- 2.01.10 Enclosure should be designed in such a way that the temperature inside the enclosure should be maintained as low as possible to arrest frequent LED failures. The body must be of corrosion resistant silicon aluminum alloy or equivalent.
- 2.01.11 The design of the LED circuitry should be such that the rated current does not exceed 60% of the maximum forward current specified for the LED and also take into account the derated value of the maximum current rating at the ambient temperature.
- 2.01.12 Surge protection should be provided by Metal Oxide Varistors.
- 2.01.13 Electrical test for high wattage dielectric at 1.5 KV for one minute, insulation resistance at 500 V DC and total wattage consumption has to be carried out at the time of inspection.
- 2.01.14 Light Intensity measurement has to be carried out.
- 2.01.15 All LEDs should be in series-parallel strings and should have EMI/ RFI Filters.
- 2.01.16 Flasher synchronization control and monitoring controller for medium intensity LED lights should be as per ICAO recommendation and all lights must flash together i.e. synchronously.
- 2.01.17 Bidder has to design the circuit to sense the current flow of each light and also to guard against any light being operated in a steady condition.
- 2.01.18 A controller has to be provided for each installation to monitor constantly the functioning of all lights. The controller should have the following features:
- Current sensor and indicator for each light, by means of an LED-based indicator.
 - Fuse for each light with corresponding MCB.
 - All the light to be fed by a common flasher unit for synchronous flashing.
 - Standby flasher unit.
 - Active warning and shut-off circuitry, with audio indicator and

automatic shut-off of power feed to AOL units in case of Flasher failure.

- Flasher Diagnostic by-pass switch.
- Photoelectric switch unit with amplifier activating a solid-state relay.
- Mimic on front fascia for diagnostic purpose.

2.01.19 A warranty of minimum five (05) years has to be provided by the manufacturer for this LED Aviation lights.

2.01.20 The flasher unit of the aviation light has to be indoor mounted. It should not be mounted at the AOL unit level, or in an outdoor environment.

2.02.00 **Temporary Aviation Warning Lights**

2.02.01 Bidder shall provide Temporary Aviation Warning Lights (with red flashing medium intensity LED type AOL conforming to ICAO guide lines) during construction above the 45M level from general ground level.

2.02.02 Temporary aviation warning lights shall be four fixtures (minimum intensity not less than 10 foot candles) LED type, located in a horizontal plane on the Chimney structure to ensure unobstructed visibility of at least one aviation warning light from aircraft at any normal angle of approach. Power for operation of the temporary aviation warning lights shall be obtained from the construction power system. Supply circuits for these lights shall be furnished, installed and maintained by the Contractor.

2.02.03 Temporary aviation warning lights shall be operated at night i.e from sunset to sunrise.

2.02.04 These lights shall continue to exist till permanent arrangement of lights are completed.

2.03.00 **Interior And Exterior Lights**

2.03.01 Exterior platforms and staircase shall be illuminated by approved industrial well glass luminaries with 150 W HPSV lamp and separate control gearbox. At least two (2) fixtures on each platform level shall be fed from aviation warning lighting board (emergency source). All staircase lights shall also be fed from emergency system.

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

2.03.03 One (1) 6/16A, 240V, single phase industrial, weatherproof type, suitable for wall/ column mounting, 3-pin receptacle (Best & Crompton make or approved equivalent) with suitable interlock shall be provided on each internal and external platform. At least two 63A, 415V, three phase industrial,



weatherproof type, 5-pin receptacles shall be provided at the internal platforms.

2.03.04 Chimney Rack & Pinion Lift Room

Industrial fluorescent luminaries with 2X40W fluorescent lamps with reflector shall be provided for Chimney Rack & Pinion Lift Room.

2.04.00 Street/Area Lighting

Time switch will be used for controlling area/outdoor/ yard lights with provision for manual override and also have the provision of proven Energy Saving Systems.

3.00.00 RATINGS & REQUIREMENTS

3.00.01 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

3.00.02 Switch, fuses, MCCB, miniature circuit breakers (MCB), busbar shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

3.00.03 All equipment and accessories shall have proper enclosure to suit the site conditions. In hazardous areas all equipment and accessories shall have flame-proof enclosure.

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

- From Lighting panels to junction boxes : 6 SQ.mm
- From junction boxes to lighting fixtures : 2.5 SQ.mm
(No. of wires per lead as required)
- From Lighting panels to receptacles (6/16A) : 6 SQ.mm

3.00.05 Heavy duty XLPE, FRLSH power cables as per IS 7098 will be used for connections from Main power Distribution Board to Lighting Panel, from Emergency power Distribution Board to Emergency Lighting Panels (ELP) & from Street/Area lighting panel to street light poles.

3.00.06 Voltage drop at the fixture end from the Main power distribution board/Emergency power distribution board bus shall not exceed 3%.

3.00.07 Circuit loading of each lighting Panel shall be done as per relevant codes/Indian Standards in such a way that almost balanced loading in all the phases i.e. R, Y & B is achieved.





- 3.00.08 At least two (2) sub circuits shall be used for illumination of a particular area.
- 3.00.09 Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.
- 3.00.10 The working plane shall be considered at 0.85 m from the floor level.
- 3.00.11 Calculation can be done through proven software program by maintaining uniformity ratio as per relevant IS.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Equipment and Material

- 4.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.
- 4.01.02 Equipment and materials furnished shall be complete and operative in all details.
- 4.01.03 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- 4.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

4.02.00 Lighting Fixtures

- 4.02.01 Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive, scratch resistant and no bright spots are produced either by direct light source or by reflection. Fixture shall conform to latest IS / IEC and its latest amendment
- 4.02.02 All lighting fixtures shall be complete with LED (energy efficient type). LED lamp fixtures shall be complete with all necessary wiring such as control gear & it's accessories ignitor, power factor improvement capacitors (if required) etc. These shall be mounted in the fitting assembly only. The Contractor shall indicate starting time of these lamps to attain full light output. Curves for starting characteristics with varying supply voltage etc. are to be furnished by the Contractor.
- 4.02.03 Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth wire connection.
- 4.02.04 Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.
- 4.02.05 **Lamp holders**





Lamp holders shall be for LED lamp. Holders shall be designed and manufactured in accordance with relevant standard to give long and satisfactory service.

4.03.00 Lamps

The LED lamps to be supplied shall conform to IS 9974 or latest edition. LED lamps shall be suitable for use in any position.

4.04.00 Lighting Panel

4.04.01 Lighting panels shall be metal-enclosed, cabinet type, fabricated from CRCA sheet steel minimum 2 mm thick, suitable for either wall/column mounting on brackets or floor mounting on channel sills.

4.04.02 Indoor Lighting Panels shall be dust and vermin-proof (IP-52); outdoor panels shall be weather-proof with canopy (IPW-55 or better).

4.04.03 Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

4.04.04 Lighting panels shall have provision of cable entry from top and bottom (as required) with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.

4.04.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Panel for connection to ground conductor.

4.04.06 Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

4.04.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85°C. Minimum size shall be 25 x 6 mm.

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

4.05.00 Panel Equipment

4.05.01 Each panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB).

4.05.02 Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.





- 4.05.03 All MCCB shall be single throw, air break, heavy duty type having quick-make quick-break contacts. Contactors shall be air break electromagnetic type. Push buttons shall be push to actuate type.
- 4.05.04 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.
- 4.05.05 Time switch in street lighting panels shall be clock switch type with ON-OFF time setting facility, which shall ensure respective ON-OFF operation in every 24 Hours cycle. Voltmeter/Ammeter shall be of accuracy class 2.0 or better as per IS: 1248. Each indicating meter shall be provided with selector switch.
- 4.06.00 **Receptacle**
- 4.06.01 Receptacles shall be heavy duty, complete with individual plug and switch as detailed in the annexure. For Residential building, Electrical room, Pump room, Control Room 16/6 Amp receptacles shall be considered.
- 4.06.02 The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.
- 4.06.03 Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.
- 4.06.04 Minimum two (2) nos. of 63 Ampere three phase four pin receptacles shall be provided at each elevation of Chimney and also at major area.
- 4.08.00 **Switch & Switch Board**
- 4.08.01 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick colour matching FRP/ Non- Hygroscopic Synthetic cover with brass fixing screws.
- 4.08.02 Switch boards/boxes located in electrical room shall be flush mounted type on brick wall with switch knob projecting outside.
- 4.08.03 Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.
- 4.08.04 Flush type receptacles where provided shall be so located that only the plug projects outside.
- 4.08.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.
- 4.09.00 **Lighting Poles**

Street Light Poles



- a) Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.
- b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).

4.10.00 **Maintenance Equipment**

4.10.01 The Bidder shall supply one (1) no. of wheel mounted adjustable aluminium ladder for the maintenance of street lights.

4.11.00 **Special Requirement**

4.11.01 All outdoor illumination fixtures, unless it is fed from photo cell/time switch controlled lighting panel, has to be provided with outdoor type local switches.

4.12.00 **Lighting Cables & Wires**

4.11.01 Lighting Cable shall be heavy duty, 1100 Volt grade, multicore stranded copper conductor, XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLSH conforming to IS 1554.

4.11.02 Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED	for	R-Phase	BLUE	for	B-Phase
YELLOW	for	Y-Phase	BLACK	for	Neutral

4.12.00 **Nameplate**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to clearly indicate their functions.

All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

4.13.00 **Grounding**

4.13.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.

4.13.02 Ground connections shall be made from ground grid. All connections to ground grid shall be done by arc welding.



- 4.13.03 Lighting Panels shall be directly connected to ground grid by two nos. 35 x 6 mm G.S flats.
- 4.13.04 Street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.I flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GI wire.
- 4.13.05 One 16 SWG G.I wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.
- 4.13.06 A continuous ground conductor of 16SWG GI Wire shall run along each exposed metallic conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.
- All junction boxes, receptacles, fixtures etc. shall be connected to this 16 SWG ground conductor.



Annexure-A

AVAILABLE POWER SUPPLY

1.0 System Voltage

Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources:

- 1.1 A.C. Supply : 415 Volt, 3 phase, 50 Hz, 4 wire effectively grounded system.

Fault Level 50KA (r.m.s. symmetrical).

2.0 Permissible Variation

Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:

- 2.1 A.C. Supply : Voltage $\pm 10\%$
Frequency $\pm 5\%$
Combined Voltage 10% (absolute sum)
+ Frequency

Annexure-B**AVERAGE LUX LEVEL FOR DIFFERENT AREAS**

Sl. No.	Location	Lux Level
1.	Switchgear/MCC/Electrical Equipment Rooms	250
2.	Street & periphery lighting	20
3.	Office Rooms	250

Medium bay fixtures shall be used where the room height is 8 M. Otherwise high bay fixtures are to be used.

- Lux level for A.C. Emergency lighting in control room shall be 50 and for other areas 20 lux.
- Lux level for main road lighting shall be 20lux and for secondary road shall be 10 lux.
- If Lux level of any specific area is not covered in above table, Vendor shall take specific confirmation from purchaser before finalization of Bid.



Annexure-C

TYPE OF FITTINGS/FIXTURES AND OTHER AUXILIARIES

1.0 LIGHTING FIXTURES & LAMPS

Each lighting fixture shall be furnished complete with associated lamp, holder and all accessories as required.

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
1.1	ILD-1	BN108C LED 20S PSU CDL WH	Commercial/decorative type, Surface/ pendant mounted green perform LED Batten [system flux $\geq$ 2000 lumens, 6500K color temperature, CRI $\geq$ 75, System efficacy $>$ 100lm/W] having minimum lifetime of 40,000 burning hours (at L70) with PC glossy diffuser. The luminaire shall be made up of CRCA sheet steel (IP20) with THD $<$ 10% and PF $>$ 0.9, similar to Philips make ENDURALED BATTEN "BN 108C LED 20S PSU CDL WH.	Swgr room / MCC room / Workshop / Maint. Shop / Office / Toilet / Corridor / Pantry / Stores
1.2	ILD-3	RC869B LED 30S 6500 W30L120 D8 GR	Decorative type, recess mounted green perform LED Batten [system flux $\geq$ 3000 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 40,000 burning hours (at L70) with high purity anodized aluminium mirrors. The luminaire shall be made up of CRCA sheet steel (IP20) with THD $<$ 10% and PF $>$ 0.9, similar to Philips make SERENO "RC869B LED 30S 6500 W30L120 D8 GR".	False Ceiling areas (Control Room / Electronic Eqpt. Room / Office / Conference room / Engineer's Room / Corridor)
1.3	OLD-1	BRP022 LED 21 CW MR S1 PSU GR	Pressure Die cast aluminium frame (IP 65) , dust free type, green perform LED Batten [system flux $\geq$ 2100 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70).The luminaire shall have inbuilt surge protection ($>$ 2KV) with THD $<$ 20% and PF $>$ 0.95, similar to Philips make BRP022 LED 21 CW MR S1 PSU GR LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Building exterior lighting / Outdoor area lighting / Outdoor eqpt. Area
1.4	OLD-2	BRP410 LED CW 072 MR FG S1 PSU GR	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, dust free type, green perform LED Batten [system flux $\geq$ 7200 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD $<$	Street lighting / boundary lighting



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SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
			20% and PF > 0.95, similar to Philips make BRP410 LED CW 072 MR FG S1 PSU GR. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	
1.5	OLD-3	BRP322 LED 128 CW HE MR FG S3 XT	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, dust free type, green perform LED Batten [system flux $\geq$ 12800 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD < 20% and PF > 0.95, similar to Philips make BRP322 LED 128 CW HE MR FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Street lighting / boundary lighting
1.6	OLD-4	BVP 120 LED 70 CW NB FG S3 XT	Pressure Die cast aluminium frame (IP 65), Compact, sturdy, dust free type, green perform LED Batten [system flux $\geq$ 7000 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection (> 2KV) with THD < 20% and PF > 0.95, similar to Philips make BVP 120 LED 70 CW NB FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Area lighting / Yard lighting / Floodlighting purpose
1.7	OLD-5	BVP122 LED 146 CW NB FG XTFC	Pressure Die cast aluminium frame (IP 66), Compact, sturdy, dust free type, green perform LED Batten [system flux $\geq$ 14600 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection (> 2KV) with THD < 20% and PF > 0.95, similar to Philips make BVP122 LED 146 CW NB FG XTFC. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Area lighting / Yard lighting / Floodlighting purpose





SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
1.8	OLD-6	BVP 120 LED 70 CW NB FG S3 XT	Pressure Die cast Aluminium frame (IP 65), Compact, sturdy, dust free type, green perform LED Batten [system flux ≥ 7000 lumens, 5500K color temperature, CRI ≥ 70 , System efficacy ≥ 90 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection (> 2 KV) with THD $< 20\%$ and PF > 0.95 , similar to Philips make BVP 120 LED 70 CW NB FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Area lighting / Yard lighting / Floodlighting purpose

Note 1: The supply also includes associated junction boxes, brackets, supports, hangers, and wires wherever applicable.

2.0 LIGHTING PANEL

- 2.1 LP-1 415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch/MCCB as incomer, 24 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
- 2.2 LP-2 415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch/MCCB as incomer, 18 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
- 2.3 LP-3 415 V A.C. Indoor Lighting panel with 415 V, 3ph, 4W bus & one 63A TP & N Switch/MCCB as incomer and 12 nos 20A , 240V 1 pole MCBs as outgoing feeder.
- 2.4 LP-4 415V A.C. Indoor type Lighting Panel with 415V, 63A, 3 ph, 4 wire bus, one (1) no. 32 A TP & N switch/MCCB as incomer, 6 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.
- 2.5 SLP 415 V A.C. Outdoor type Panel with 415 V, 100A, 3 ph, 4 wire bus, one 100A TP & N switch/MCCB as incomer, 18 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.

The lighting panel shall be provided with 63A contactor, frequency compensated timer switch, photo-cell switch push- buttons for automatic control of street/area lighting with provision for manual override.

- 2.6 FLP Outdoor, lockable type Isolating switch of 415V, 63A, 3 ph, 4 wire TP & N. with 2 mm sheet steel/cast iron cubicle.



3.0 RECEPTACLE

- 3.1 RA 6A, 240 V, 2 pole, 3 pin with third pin earthed, suitable for flush mounting in office areas and control room. The switch shall be also flush mounted piano type. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).
- 3.2 RB 16A, 240V, 2 pole, 3 pin with third pin earthed, wall/ column mounted, metal clad gasketed construction, 20mm conduit entry, screwed metal cover tied to it by a metal chain, weatherproof suitable for indoor/outdoor installation. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).
- 3.3 RC 63A, 415 V, 3 phase, 4 pin interlocked plug and switch with earthing contact, wall/column mounted, metal clad gasketed construction, weatherproof, suitable for loop-in/loop-out connection of 4/C-35 Sq.mm XLPE cable. These shall be fed from AC Distribution Board/Station MCC. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).
- 3.4 RD 125 A, 415 V, 3 phase 5 pin interlocked plug & switch with fifth pin earthed, wall/column mounted metal clad gasketed construction, weatherproof, suitable for loop in and loop out connection of 3-1/2C -95 Sq.mm XLPE cable. These shall be fed from A.C-Distribution Board/Station MCC. Application at all Transformer Yard for Oil Filtration machines and other areas. Degree of protection shall be IP 65.

4.0 CEILING FANS

- 4.1 FA 1200 mm sweep ceiling fan with regulator, down rod and canopy.
- 4.2 FB 1400 mm sweep ceiling fan with regulator, down rod and canopy.

5.0 LIGHTING POLES

- 5.1 TA/TB Single arm/double arm swaged and welded steel pole with junction box and all accessories.

6.0 SWITCHBOARD

- 6.1 S-1 Switch board with 1-6A switch.



6.2 S-2 Switch board with 3-6A switch and 1-6A receptacle.

6.3 S-3 Switch board with 6-6A switch and 1-6A receptacle.

7.0 MISCELLANEOUS ITEMS

7.1 M1 10 m high car wheel mounted aluminium ladder.

7.2 M2 Adjustable free-standing aluminium ladder height adjustable from 5 m to 10 m.+

7.3 M3 Portable Emergency light set complete with one 20W tube light, battery, battery charger and all other accessories.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-B
SECTION-III
SUB-SECTION-V
TECHNICAL SPECIFICATION
CABLES**



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-V
Cables**



CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE OF SUPPLY	1
2.00.00	DESIGN CRITERIA	1
3.00.00	SPECIFIC REQUIREMENTS	2
4.00.00	TESTS	2

ATTACHMENTS

ANNEXURE-A	LV POWER CABLE	3
ANNEXURE-B	CONTROL CABLE	4





VOLUME: II-B
SECTION-III
SUB SECTION-V
CABLES

1.00.00 SCOPE OF SUPPLY

1.01.00 Cables shall be furnished in accordance with this specification and the following annexures: -

- a. LV. Power Cables : Annexure A
- b. Control Cables : Annexure B

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

1.03.00 Special tools and tackle.

2.00.00 DESIGN CRITERIA

2.01.00 The Cables will be used for connection of power and control circuits of the auxiliary electrical systems.

2.02.00 Cables will be generally laid on ladder type trays or drawn through conduits or directly buried in ground depending on layout requirement.

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

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

2.05.00 The outer sheath of power and control cables shall have rodent and termite repulsion treatment.

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

2.07.00 The allowable voltage drop at terminal of the connected equipment shall be maximum 2.5% at full load while choosing the conductor size and calculations shall be submitted for purchaser's approval. In case of squirrel cage induction





motors, the cable size shall be so chosen that the motor terminal voltage does not fall below 80% of the rated voltage, at the time of starting.

3.00.00 SPECIFIC REQUIREMENTS

3.01.00 L.V. Power Cables

The type and quantity shall be furnished as indicated in Annexure -A

3.02.00 Control Cables

The type and quantity shall be furnished as indicated in Annexure -B

3.03.00 Cable identification

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

- a) Manufacturer's name or trade mark
- b) Voltage grade
- c) Year of manufacture
- d) Type of insulation, e.g. XLPE/PVC etc.
- e) No. of core and size of cables.
- f) Type of improved fire performance, e.g. FR/FR-LSH
- g) IS number

4.00.00 TESTS

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



Annexure-A

LV POWER CABLE

- 1.0 1100 V grade, 90° C continuous rating under normal condition and 250°C under short circuit condition rating, XLPE heavy duty, power cable conforming to following requirement and in line with IS 7098. IS 8130 & IS 5831 and IS 3975.
- 1.1 Conductor : Stranded and compacted plain aluminium of grade H2 for cable sizes above 2.5 mm² and class 2 stranded high conductivity annealed plain copper for cable sizes upto 2.5 mm² conforming to IS:8130.
- 1.2 Insulation : Extruded cross-linked polyethylene (XLPE) conforming to IS:7098 (Part-3)
- 1.3 Core Identification : By color coding
- 1.4 Inner Sheath : Extruded PVC compound conforming to type ST2 of IS:5831 for multicore cable. Single core cables shall have no inner sheath.
- 1.5 Armour : Galvanised single round steel wire armour for twin and multicore cables.
- Non-magnetic hard drawn aluminium single round wire conforming to H4 grade for single core cables.
- 1.6 Overall Sheath : Extruded FRLS PVC compound conforming to type ST2 of IS:5831. having improved fire performance category and type as stated below.
- | Category | Type |
|----------|--|
| C2 | FRLSH (Fire Retardant Low smoke and halogen evolution) |
- 1.7 Drum Conforming to IS-10418(Wooden Drum)





Annexure-B

CONTROL CABLES

- 1.0 1100 V grade 70°C continuous rating under normal condition and 160°C under short circuit condition rating PVC Control cable (YWY) conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.
- 1.1 Conductor : Stranded non-compacted and circular, high conductivity annealed plain copper, generally conforming to IS:8130.
- 1.2 Insulation : Extruded PVC compound conforming to type A of IS : 5831.
- 1.3 Core Identification : By color coding and numbering at interval of 100mm or less
- 1.4 Inner Sheath : Extruded PVC compound conforming to type ST1 of IS:5831 for multi-core cables. Filler shall be of same material as of inner sheath i.e. ST1. Single core cables shall have no inner sheath.
- 1.5 Armour : Galvanised single round steel wire for twin and Multi-core cables.
- 1.6 Overall Sheath : Extruded PVC compound conforming to type ST1 of IS 5831 having improved fire performance category and type as stated below.
- | Category | Type |
|----------|--|
| C2 | FRLSH (Fire Retardant Low smoke and halogen evolution) |
- 1.7 Drum : Conforming to IS-10418 (Wooden Drum)





Tender Specification
for
Chimney

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

VOLUME: II-B
SECTION-III
SUB-SECTION-VI
TECHNICAL SPECIFICATION
UNINTERRUPTIBLE POWER SUPPLY (UPS)



Development Consultants Pvt. Ltd.

Vol. II-B/Section-III
Sub-section-VI
Uninterruptible Power Supply (UPS)



VOLUME: II-B
SECTION-III
SUB-SECTION-VI

UNINTERRUPTIBLE POWER SUPPLY (UPS)
(FOR RATING BELOW 3KVA)

01. Type	: Packaged Unit, Solid-state SCR/ power Transistor & Microprocessor controlled.
02. Duty	: Continuous
03. Enclosure	: Sheet steel, IP-42
04. Transformer	: Ferro-resonant
05. Inverter	: Solid state pulse width modulated
06. Inverter Capacity	: To be decided by the bidder on load calculation. 25% extra capacity margin to be considered.
07. Control	: Microprocessor based.
08. Battery	: 220 Volt, Ni-Cd vented type, pocket plate high discharge battery of adequate capacity to meet the requirement of UPS, generally confirming to IS-10918
09. Total harmonic distortion	: < 2%
10. Harmonic attenuation	: 400%
11. Line regulation	: Better than $\pm 5\%$
12. Load regulation	: Better than $\pm 3\%$
13. Spike attenuation	: 3000: 1
14. Power factor	: Self-correcting > 0.95
15. Metering display	: Frequency, Battery, input, output voltage & % load
16. Status display	: ON, on battery, low battery, self-diagnostic malfunction alarm with SPDT potential free





**Tender Specification
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**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

contacts rated at 230 VAC, 5A for each alarm.

17. Output
 - a) Voltage : 240 V A.C, 50 Hz, 1-phase +/- 1.0%
 - b) Frequency : 50 Hz (+/- 0.5%)
 - c) Load Power factor : 0.8%
 - d) Wave form : Sinewave
18. Input
 - a) Voltage : 180V to 270V A.C
 - b) Frequency : 45 to 60 Hz
 - c) Power Factor : 0.92
19. Battery back-up Capacity : 60 Minutes at full load
20. Charger : Built-in
21. Static switch : Built-in
22. Quantity : As required
23. Rating / Capacity : 125% of System powering capacity





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-B

SECTION-III

SUB-SECTION-VII

TECHNICAL SPECIFICATION

GROUNDING AND LIGHTNING PROTECTION



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-VII
Grounding & Lightning Protection**



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GROUNDING	1
2.00.00	LIGHTNING PROTECTION	2





VOLUME: II-B

SECTION-III

SUB-SECTION-VII

GROUNDING AND LIGHTNING PROTECTION

1.00.00 GROUNDING

- 1.01.00 Bidder shall provide a complete grounding system as needed for the RCC chimney. A ground mat, preferably circular type, of diameter at least five (5) meter more than the chimney foundation diameter shall be laid.
- 1.02.00 The grounding installation work shall conform to the requirements of the Indian Electricity Rules and Code of Practice for Earthing (IS: 3043) and relevant IEC as amended up-to-date.
- 1.03.00 The main ground mat shall be of bare MS round bar of at least 40 mm dia buried in earth at a min. depth of 1000 mm below finished grade level. Earth electrode of size 40 MM dia x 3 M length driven into the ground and connected to the ground grid conductor shall be provided, as required, to bring down the ground resistance.
- 1.04.00 Riser from the ground grid shall be at least 40 mm dia MS round bar and shall project 300 mm above grade / concrete floor level. All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Above grade 50mmx6 mm galvanized mild steel (450 g/m2 zinc coating min) flats shall be run as main ground conductors securely fixed at intervals not exceeding 1500 mm.
- One end of the galvanized mild steel flat shall be connected to the MS round bar riser by electric arc welding and the other end to the equipment by welding/ bolting, as necessary, subject to approval of the Consultant. All welded portion shall be painted with bituminous paints against possible corrosion.
- 1.05.00 The chimney ground mat shall be connected to the plant station ground mat by 40 mm dia MS round bar at two (2) points.
- 1.06.00 Ground grid resistance of the grounding system shall be less than one (1) ohm.
- 1.07.00 All the metallic parts such as platform, railing, pull boxes, junction boxes etc. shall be grounded using GI wire of suitable size to the nearest GS flat.





2.00.00 LIGHTNING PROTECTION

Lightning protection system shall conform to the requirements of IS:2309 & NFPA-780 as amended up-to-date. The work is subject to approval of the Owner/ Owner's Consultant.

2.01.00 Air Termination Rod

The chimney shall be provided with required no. of 40 mm dia., 4000mm long, GI air termination rod with standard GI dome and spikes on one end and 150mm x 6mm thick. MS plate welded to the other end. The complete unit shall be lead covered after fabrication. The lightning conductors shall be securely anchored with at least two (2) suitably spaced adequate size GI lead covered clamps near the top of the stack. Air termination rod shall be mechanically and electrically connected by the use of pressure type fittings to the cap ring and to a continuous circumferential band.

2.02.00 Circumferential Band

The circumferential band shall be 50mmx6mm GI lead covered flat fixed to the chimney at an interval not more than 1.0 m. This shall be mounted with suitable anchors at such a height as to be accessible from the top of platform for maintenance. The anchors shall be embedded in concrete wall of the stack. Further these circumferential bands round the chimney shall be interconnected by 50mm x 6mm thick GI lead covered flat.

2.03.00 Down Conductors

Required no. of 50mm x 6mm GI flat down conductors shall be provided. These shall be not more than 15m apart on the periphery of the stack at the ground level. The down conductor shall be connected to circumferential band at the top portion of the stack and to the grounding system at the bottom. These conductors shall be continuous as far as practicable. Intermediate breaks shall be electrically bonded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable.

These conductors shall be embedded in the outer surface of the concrete shell and shall come out of the shell below grade level. Conductors embedded in concrete shall have a minimum cover of 50 mm. Railings and steel in the platforms are to be grounded with 50mm x 6mm thick GI flat conductors which are in turn tied to the down conductors. Railings and steel in platforms, ladder, exposed steel works shall also be bonded to down conductors with 50mm x 6mm GI flat. Chimney ladder shall be electrically connected to the down conductors at top and bottom of the ladder. For this, the two (2) lower pairs of insert supporting the ladder shall be adequately connected to the earthing system and the top laid inserts shall be connected to the circumferential band connecting the down conductors. Each down conductor shall be connected to earthing electrode through test point. Conductor from the earthing electrode to a height of about 300 mm above ground level shall be 40 mm MS round bar and thereafter 50mm x 6mm GI flat run.



Each of the above earthing electrode shall be connected to the earthing mat at two points.

2.04.00 Testing Points

Each down conductor shall be provided with a testing point installed in GI box embedded on the outside surface of chimney at a height of 1.5m from the ground level. Testing point shall consist of 50mm x 6mm thick GI flat with hot dip galvanized bolts, nuts and washers. Incoming and outgoing portion of down conductor at the test point shall be galvanized.

02.05.00 Clamps, Anchors etc.

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

02.06.00 Vertical and Horizontal Reinforcing Bars

All vertical reinforcing bars at the top and the bottom portion of the chimney shall be electrically connected to the nearest horizontal reinforcing rods. At each place where vertical reinforcing rods shall be spliced, each of the spliced rods shall be electrically connected to at least one (1) horizontal reinforcing rod. The nearest vertical reinforcing bar shall be connected with down conductor at its upper and lower extremities and an additional connection shall be made at every 60meter interval by suitable clamping arrangement.

The ohmic resistances of the lightning protection system complete with air termination but without the earth connections, shall be a fraction of an ohm so as to permit heavy current flow easily.

2.07.00 Chimney staircase/ladder shall be electrically connected to the down conductors both at top and bottom. For this, the two lower pairs of inserts supporting the staircase shall be adequately grounded by connecting to the circumferential conductor connected to the down conductor. All intermediate breaks in the staircase should be electrically bonded to maintain continuity from top to bottom.

2.08.00 Temporary Lightning Protection

Temporary lightning protection system during construction to meet ICAO and DGCA requirements shall be provided by the bidder, complete with all the necessary fittings, hardware etc. required for installation. After top lift of the chimney shell has been completed, temporary air terminations, which may consist of reinforcing bars, should be installed at the top to serve as temporary protection until the lining and cap are completed and permanent air terminations, conductors etc. are complete.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-B
SECTION-III
SUB-SECTION-VIII
TECHNICAL SPECIFICATION
ERECTION**



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Sub-section-VIII
Erection**



CONTENTS

SECTION-III

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE OF WORK	1
2.00.00	SCOPE OF SUPPLY	1
3.00.00	DESCRIPTION OF ITEM TO BE SUPPLIED	1
4.00.00	SCOPE OF SERVICES	7





VOLUME: II-B
SECTION-III
SUB-SECTION-VIII
ERECTION

1.00.00 SCOPE OF WORK

- 1.01.00 Scope of work shall cover complete and efficient erection, testing, commissioning and putting into successful commercial operation of all Outdoor and Indoor electrical equipment supplied under Chimney package.
- 1.02.00 Scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

- 2.01.00 Items to be supplied
- 2.01.01 Miscellaneous steel structures, tray supports, hangers & brackets for cable trays, mounting of local panels, push button stations etc. shall be supplied. Any material or accessory, which may not have been specifically mentioned but which is usual and/or necessary shall be supplied.
- 2.01.02 Insulating rubber mat of 1 meter width and conforming to IS 15652-2006 for laying in the front along the entire length of panels for the safety of operating personnel. The mat shall conform to the appropriate voltage class as per the said Standard.
- 2.01.03 All hardware, materials and miscellaneous items required to complete the erection job under this specification. All such hardware, materials and accessories shall be brand new ones of reputed make.

3.00.00 DESCRIPTION OF ITEM TO BE SUPPLIED

3.01.00 Junction Box

- 3.01.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, single door / double door, outdoor type with rain canopy, dust vermin and damp proof, generally conforming to IP: 55.
- 3.01.02 Junction boxes shall be complete with neoprene gasketed inspection cover, conduit knock out, terminal blocks and painted with one coat of red oxide primer and two finishing coats of pebble gray (RAL 7032) epoxy paint.





- 3.01.03 Junction boxes for outdoor use shall be weather proof IPW: 55 and shall be epoxy painted.
- 3.01.04 Junction boxes shall be of two types viz. one suitable for control wiring and the other with terminals for power cable terminations. Junction boxes for power cable terminations shall have minimum nine (9) nos. of terminals. Size of terminals shall be suitable to accommodate cables of sizes as required.
- 3.01.05 The junction boxes shall have the following indelible markings:
- i) Circuit nos. on top by white-stenciled paint at site.
 - ii) Circuit nos. with ferrules (inside) as per approved drawing.
 - iii) Danger sign in case of 415V circuit.
- 3.01.06 Junction boxes shall be provided with two nos. (2) earthing terminals complete with nuts and washers suitable for connection of 8 SWG GI wire.
- 3.02.00 **Cable Trays**
- 3.02.01 Cable trays shall be pre-fabricated ladder type sheet steel with hot dip galvanizing furnished in standard length of 2.5 meters and thickness of 2.0mm.
- 3.02.02 Standard cable tray width shall be 600 mm. However, trays with 450, 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose, some perforated type cable trays of width 150 mm may be used and 600, 450, 300 mm perforated trays may be used depending on site requirement.
- 3.02.03 Cable trays shall be complete with all necessary hot dip galvanized sheet steel accessories such as coupler plates, ground continuity connections, nuts, bolts, washers, hangers/clamps etc. Also, horizontal/vertical bends, horizontal/vertical Tee, Reducers, Horizontal cross-pieces, protective covers shall be supplied along with straight runs in order to take care of cable tray alignments in different routes.
- 3.02.04 All fittings like horizontal/vertical elbow, horizontal crosspiece, reducer, horizontal tee etc. should be prefabricated.
- 3.02.05 Cable trays, fittings & accessories as well as elbows, reducers, tees, crosses etc. shall be fabricated out of 14 gauge (2 mm thick) hot rolled mild steel sheets.
- 3.02.06 The Contractor shall supply 14 gauge (2 mm thick) perforated type hot rolled mild steel sheet covers for vertical cable shafts upto a height of 2.5 meters from floor level. The perforated covers used for the vertical raceways may be of one or more pieces along the width of the raceway, depending on the width of the raceway and shall be bolted to the structural framework of the raceway.





- 3.02.07 The cable trays, fittings and accessories including all bolts, nuts, screws, washers etc. shall be hot dip galvanized after fabrication as per IS: 2629. Galvanizing shall be uniform, clear, smooth and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel will have to be re-galvanized at Contractor's cost.
- 3.02.08 The amount of zinc deposited shall not be less than 610 gms per square meter of surface area and in addition the thickness of the zinc deposit at any spot whatsoever, shall not be less than 80 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elcometer or any other instrument and reject any component, which shows thickness of zinc at any location to be less than 80 microns.
- 3.02.09 The Contractor shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and that such tests are adequate to demonstrate that the equipment will comply with the requirement of this specification.
- 3.02.10 The tolerance on dimensions shall be in accordance with appropriate Indian Standards. The extent of the tests to be performed by the Contractor shall include but not be limited to the following:
- Deflection Test : A 2.5 meter straight section of each type of cable trays shall be simply supported at the two ends. A uniformly distributed load of 100 Kg per meter will be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7 mm.
- 3.03.00 **Terminals**
- 3.03.01 Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.
- 3.03.02 Each control cable terminal shall be suitable for connection of 2 nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.
- 3.04.00 **Cable Termination & Jointing Kits**
- 3.04.01 The Bidder shall supply cable termination and jointing kits in requisite quantity L.T. Power, Control Cables, Instrumentation Cables etc. along with all accessories & consumables required for making termination and joints complete. All the materials and components of the termination/joints shall be suitable and compatible with the type of cables for which the terminals/joints are intended.



3.04.02 The straight through joints L.T. cables shall be of Tapex/Paracast/Parawrap type. Cable joint or end terminations on Electrical equipment shall be suitable for Indoor & Outdoor use, as the case may be.

3.04.03 Glands and lugs required for termination of L.T. and instrumentation cables shall be supplied by the Contractor in required quantity.

3.05.00 **Cable Glands**

Cable glands shall be tinned brass gland, double compression type complete with necessary armour clamp and tapered washer etc. Cable glands shall match with the sizes of different LT/Control cables.

3.06.00 **Cable Lugs**

All cable lugs shall be Cd plated copper. Cable lugs shall be suitable for termination of different cross-sections of L.T./Control/Instrumentation cables and shall be of following types :

- i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.
- ii) Copper tubular terminal end for solderless crimping to copper conductors. Solderless crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/ instrumentation cables shall be PVC insulated/sleeved type.
- iii) Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ring type/U type to suit the terminals provided in the panels.

3.07.00 **Conduits & Accessories**

3.07.01 Conduits shall be of rigid steel, hot-dip galvanized, furnished in standard length of 5 meters, threaded at both ends.

3.07.02 Conduits diameter upto and including 25mm size shall be of 1.6 mm and conduits above 25 mm diameter shall be of 2.0 mm. Minimum diameter of conduits shall be 20 mm.

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

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





- 3.07.05 Steel conduits with interior coating of silicon epoxy ester for ease of wire/cable pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanized. These shall be supplied in standard length of 51V! with minimum wall thickness as specified in IS: 9537. In chemical handling areas, Battery Room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.
- 3.07.06 For sizes above 63 mm mild steel pipes with necessary fittings & accessories shall be provided and installed by the Contractor. Pipes shall be manufactured by electric welding process. These pipes shall be of heavy-duty class as per IS: 1239 and shall have ISI mark. Pipes shall be supplied in lengths of approximately 5 meters. Pipes, fittings & accessories shall be hot dip galvanized both on inside and outside.
- 3.07.07 Flexible conduits shall comply with IS: 3480. They shall be made with bright, cold-rolled, annealed and electro-galvanized mild steel strips. Flexible conduits shall be used between embedded conduits / pipes and the motor terminals. Flexible conduits shall also be used between fixed conduit and any equipment terminal boxes where vibration is anticipated or equipment that require regular removal.
- 3.07.08 Rigid PVC conduits conforming to IS: 4985 shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are straight ones generally, the PVC pipes with special Bell Mouthing shall be of 110 mm, 160 mm & 200 mm outside diameter and shall be suitable for working pressure, of 6 kg/sq. cm. The length of each pipe shall be 5 to 6 meters. Necessary fittings & accessories as may be required for the installation shall also be provided
- 3.08.00 **Local Control Boards/Panels**
- a) Local Control Boards may consist of a number of vertical panels mounted side-by-side, in which case, they shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close-fitting, and unobtrusive.
 - b) The control boards/panels shall be totally enclosed type, conforming to degree of protection IP-54 or better.
 - c) Generally, the local control boards/panels shall be free-standing, floor-mounted, dead-front assemblies. In some cases, however, wall-mounted type control boards/panels may also be accepted.
 - d) Floor-mounted control boards/panels shall be assembled on channel/ angle base plates with anti-vibration mountings and stainless steel kick-plates.
 - e) Control boards/panels shall be of folded sheet steel construction, minimum 2 mm. thick, and free from all surface defects.

The boards/panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.

- f) All floor-mounted panels shall have rear door.
- g) Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.
- h) All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.
- i) Working height of the panels shall be limited between 550 mm and 1800 mm above floor level.

3.09.00

Local Push Button Stations

- a) L.P.B. Stations shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketed construction, suitable for outdoor use without canopy, and conforming to degree of protection IP-55 or better.
- b) L.P.B. Stations shall be suitable for column/structure/wall mounting and shall be complete with push-buttons, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing terminals, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing terminals shall be suitable for connection to one (1) no. 8 SWG G.I. wire.
- c) L.P.B. Stations shall be of the following basic type and equipped with:
 - Type-A : One (1) START push-button and one (1) STOP push-button.
 - Type-B : One (1) OPEN push-button, one(1) CLOSE push-button, and One (1) STOP push-button.
 - Type-C : Flame proof type as per IS-2148. one (1) START push-button and one(1) STOP push-button.
 - Type-D : One (1) STOP Lock-out switch.

Any other type of L.P.B. Station, if required, shall be subject to approval of the Purchaser .

- d) OPEN, CLOSE, and START push-buttons shall be spring return to normal type. STOP push-buttons shall have mushroom head actuator with press-to-latch and key-to-release feature.



- e) OPEN/START push buttons shall be GREEN, STOP push buttons shall be RED, and CLOSE buttons may be YELLOW.
- f) All push-buttons shall have a minimum of two (2) Normally-Open and two (2) Normally-Closed electrically separate contacts, rated minimum 10 A at operating voltage.
- g) Wiring shall be done by 1/C - 2.5 sq.mm. 1100V grade, PVC insulated, stranded copper conductor, cable. Each wire shall be identified at both ends by ferrules with wire designation.
- h) Terminals shall have provision for connecting at least two (2) nos. 2.5 sq.mm. copper cable and shall be rated for carrying continuously minimum 10 A at 240V A.C. and 2 A at 220V D.C

4.00.00 SCOPE OF SERVICES

The work includes but not limited to the followings:

- 4.01.00 Furnishing of all erection tools and tackle, implements, supplies, consumables and hardware for timely and efficient execution of the erection work.
- 4.02.00 Transport vehicles necessary for efficient transportation of equipment from stores to site of erection and excess materials back to stores.
- 4.03.00 Entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.
- 4.04.00 Erection work of equipment shall be carried out in a neat and efficient way so as not to impair their normal functioning in any way.
- 4.05.00 All erection work under this specification shall be carried out strictly in accordance with the approved drawings.

4.06.00 Methods and Workmanship

- 4.06.01 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.
- 4.06.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

4.07.00 Consumables and Hardware

- 4.07.01 The Contractor shall furnish all erection materials, hardware and consumables required for the completion of the installation.
- 4.07.02 The materials shall include but not be limited to the following:





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, Paints, electrical tape, soldering materials etc.
- b) Hardware : Bolts, nuts, washers, screws, brackets, supports, Clamps, hangers, saddles, cleats, sills, shims etc.
- c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

4.07.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

4.08.00 **Cleaning up of Work Site**

4.08.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

4.08.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.



CABLING
NOTES & DETAILS

DWG. NO. 18A09-DWG-E-0400

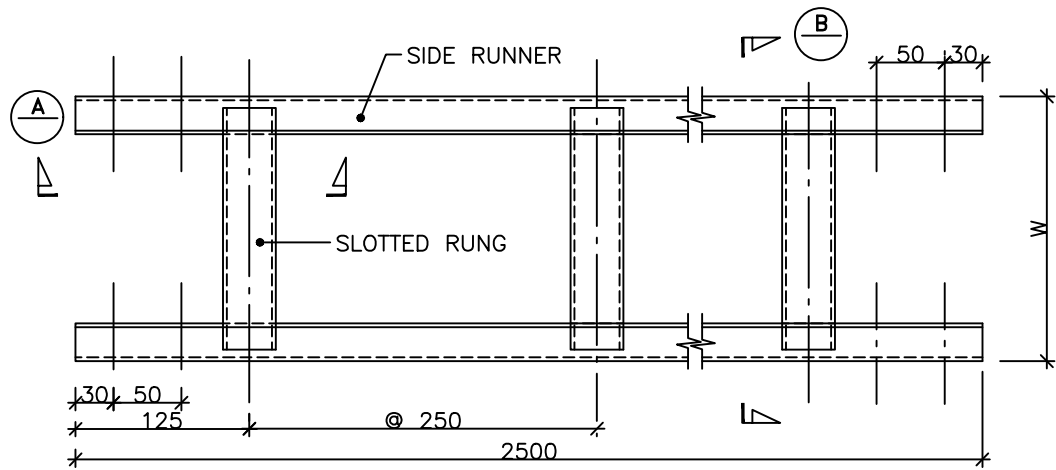
FOR TENDER PURPOSE ONLY

NOTES:—

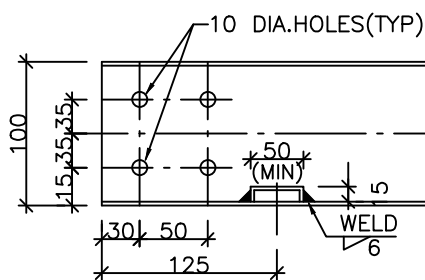
1. THE CABLING WORK SHALL BE DONE IN ACCORDANCE TO THE STIPULATION OF THE SPECIFICATION.
2. THE CABLING WORK SHALL COMPRISE OF THE FOLLOWING AND/OR AS STIPULATED IN THE SPECIFICATION:—
 - ON TRAY : LAYING, DRESSING, CLAMPING OF CABLES ON TRAY, FIXING OF CABLE TAG INCLUDING THE SUPPLY OF CABLE CLAMPS, CABLE TAGS AND FIXING HARDWARES.
 - BURIED : EXACAVATION OF EARTH, FILLING BY SAND, PROVIDING BRICK PARTITION, LAYING AND DRESSING OF CABLE, FIXING OF CABLE TAG, SAND COVERING FOLLOWED BY FIXING OF PRECAST COVER, BACKFILLING BY GOOD EARTH FOLLOWED BY COARSE EARTH INCLUDING THE SUPPLY OF CABLE TAG, SAND, BRICK, PRECAST COVER.
 - SHALLOW TRENCH : LAYING, DRESSING, FIXING OF CABLE TAG, FILLING WITH SAND AND FIXING OF BRICK COLUMN INCLUDING SUPPLY OF SAND, BRICK AND CABLE TAG.
 - DUCT BANK: PULLING OF CABLE AND FIXING OF CABLE TAG.
3. TERMINATION WORK SHALL BE DONE IN ACCORDANCE TO THE STIPULATION OF THE SPECIFICATION INCLUDING SUPPLY OF LUGS, GLANDS FOR CONTROL CABLE.
4. ARMOUR/SCREEN OF MULTI CORE CABLES SHALL BE GROUNDED AT BOTH END.
5. ARMOUR/SCREEN, IF ANY, OF SINGLE CORE CABLE SHALL BE GROUNDED ONLY AT SOURCE END.
6. ALL WALL/FLOOR OPENINGS FOR CABLE ENTRY SHALL BE SUITABLY SEALED WITH FIRE RATING OF 90 MINUTE AFTER CABLE ERECTION.
7. CLAMPING OF ADJACENT CABLES ON THE SAME RACK SHALL BE STAGGERED TO AVOID FOULING OF THE CLAMPING BOLTS.

FOR TENDER PURPOSE ONLY

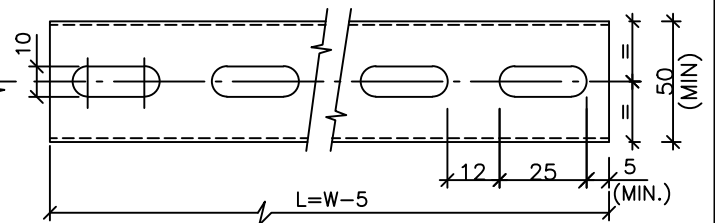
					CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 01 OF 28
APPVD.	REVWD.	CHKD.	REV.	DATE		REV. -



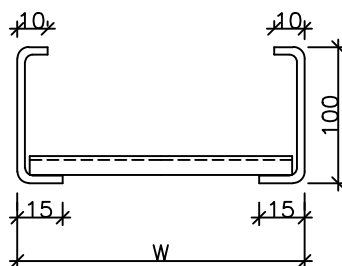
LADDER TYPE CABLE TRAY



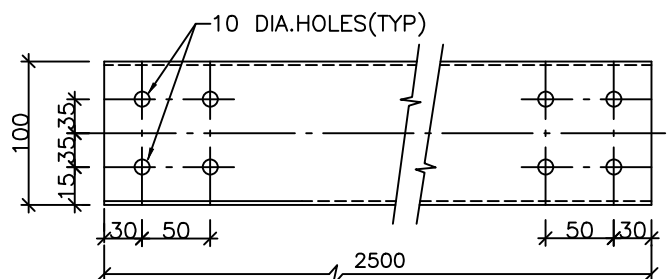
SEC - A



SLOTTED RUNG



SEC - B



SIDE RUNNER

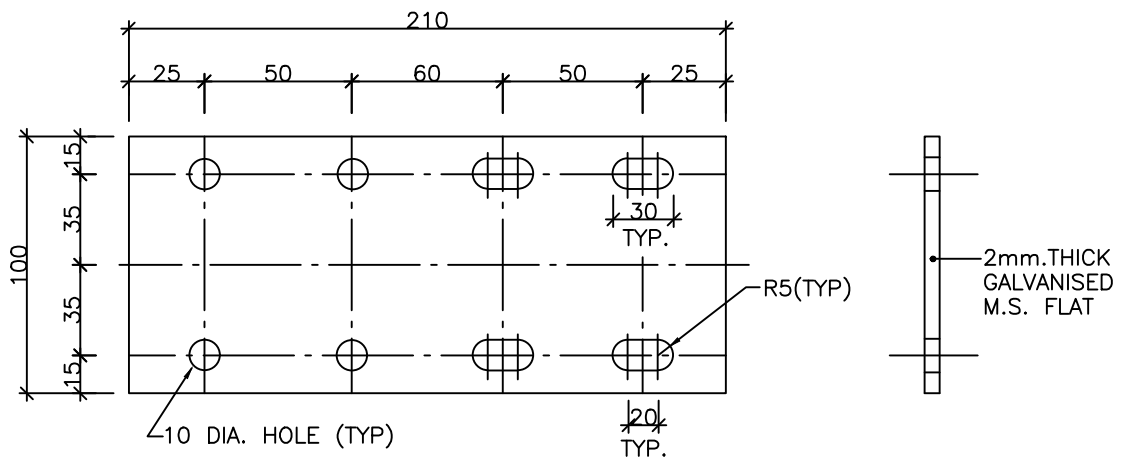
MATERIAL : M.S. SHEET 14 SWG.(2mm.THK.)
FINISH : HOT DIP GALVANISED

NOTE :-

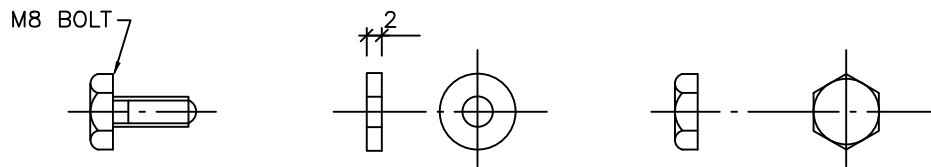
1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 02 OF 28	REV. -



SIDE COUPLER PLATE



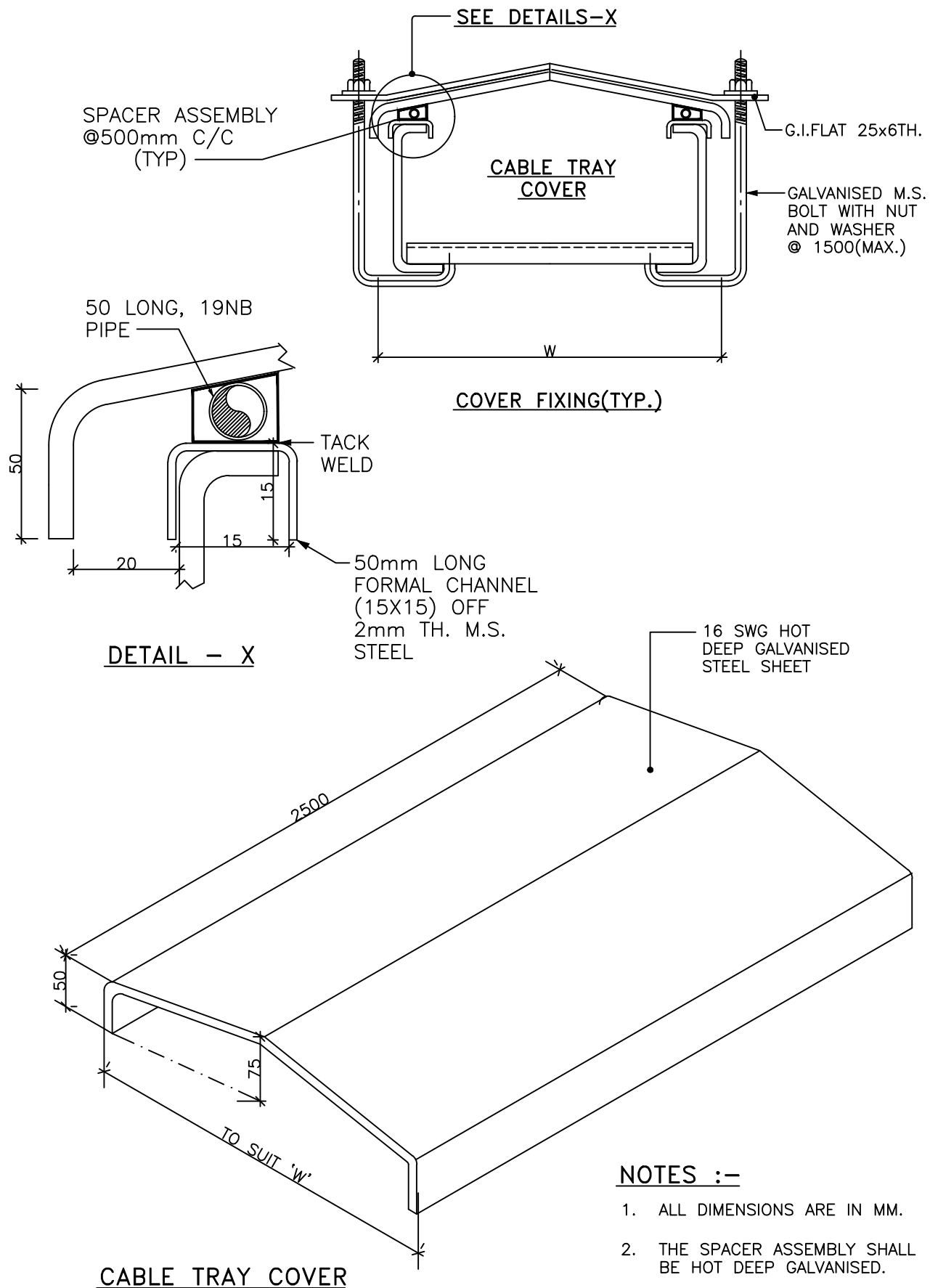
M8 BOLT, WASHER & NUT
(FOR CABLE TRAY JOINT)

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

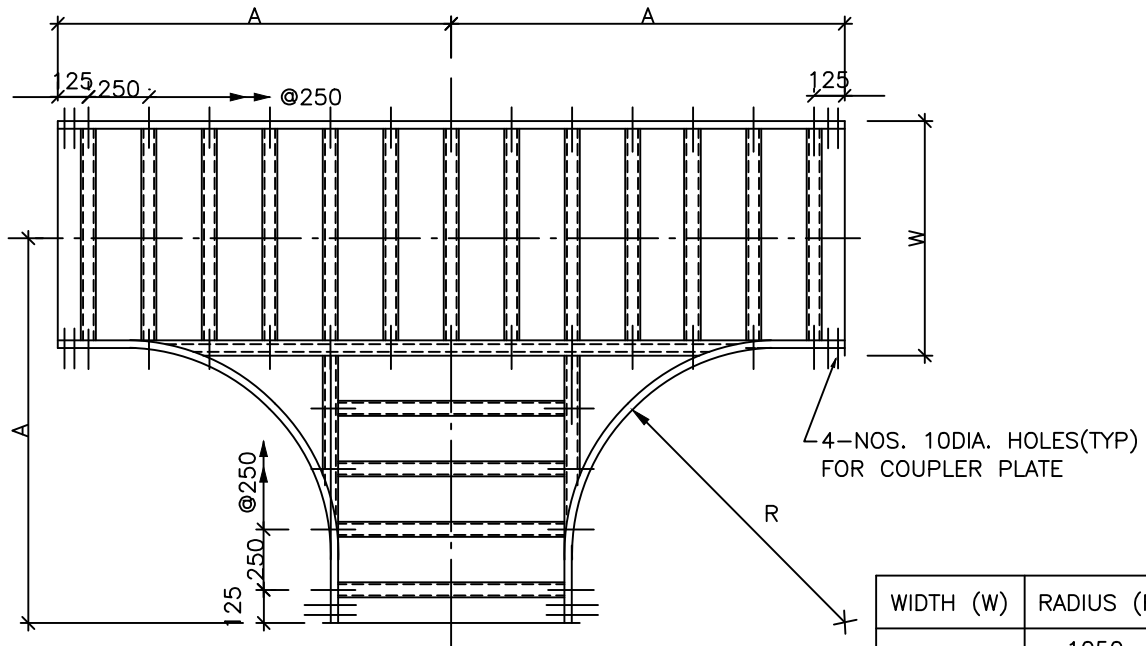
FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
						 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09 SCALE : NTS		
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0400 SHT. 03 OF 28		REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE						



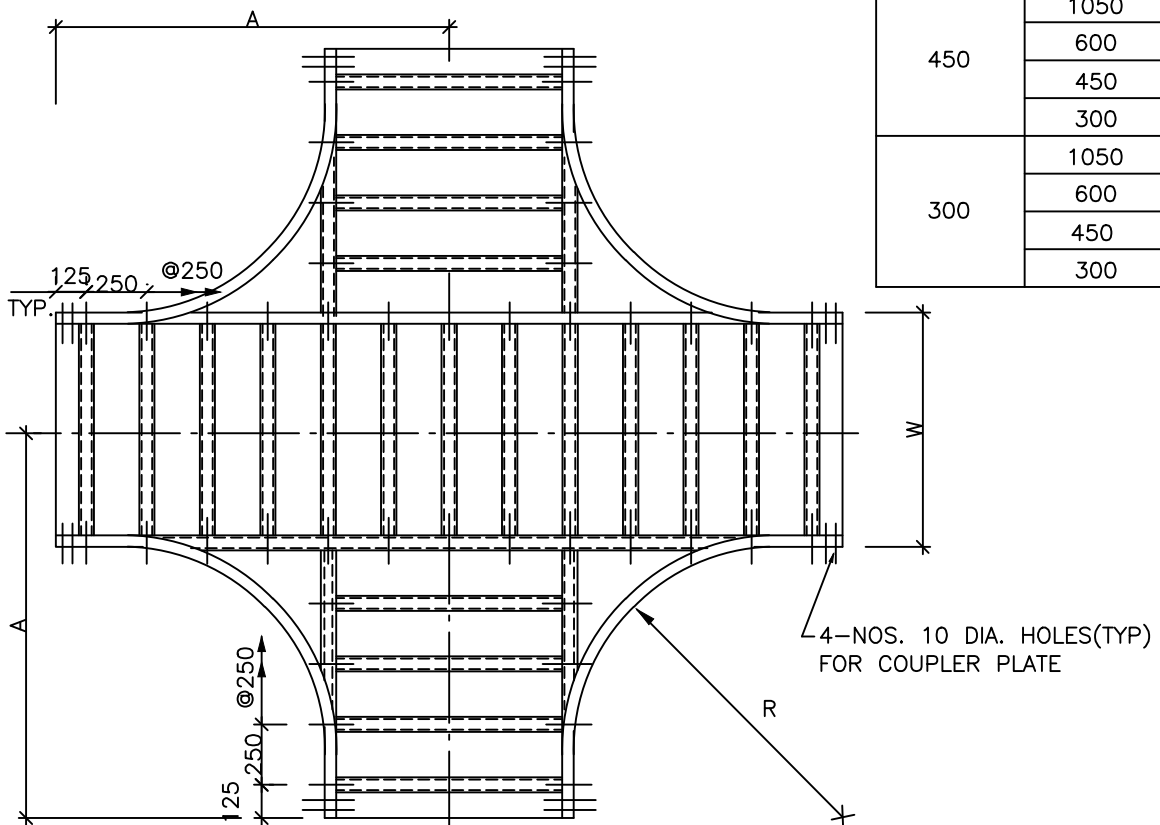
FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 04 OF 28	REV. -



**PLAN
HORIZONTAL TEE**

WIDTH (W)	RADIUS (R)	A
600	1050	1475
	600	1025
	450	875
	300	725
450	1050	1400
	600	950
	450	800
	300	650
300	1050	1325
	600	875
	450	725
	300	575



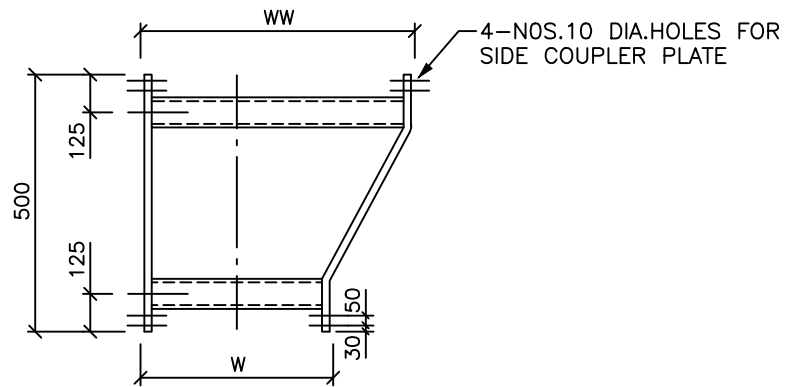
**PLAN
HORIZONTAL CROSS**

NOTES :-

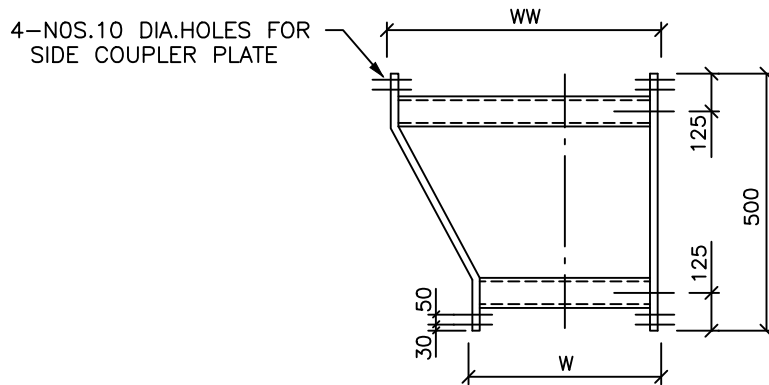
1. ALL DIMENSIONS ARE IN MM.
2. FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE.

FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 05 OF 28 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



PLAN
LEFT HAND REDUCER



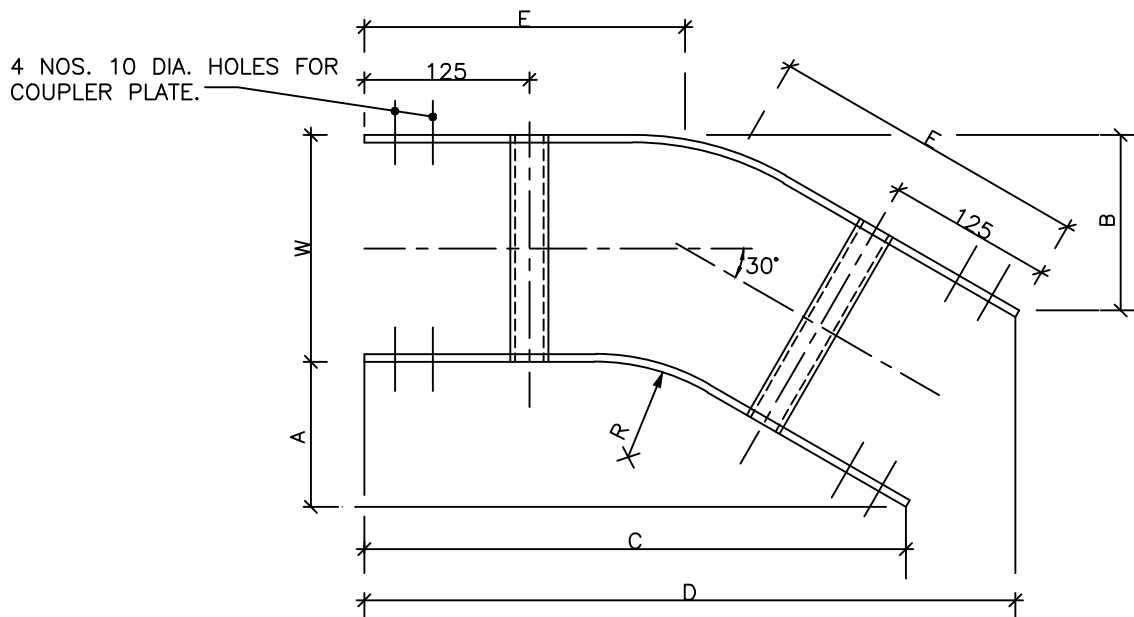
PLAN
RIGHT HAND REDUCER

WIDTH	WW	600	600	450
	W	450	300	300

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY



PLAN
30° HORIZONTAL ELBOW

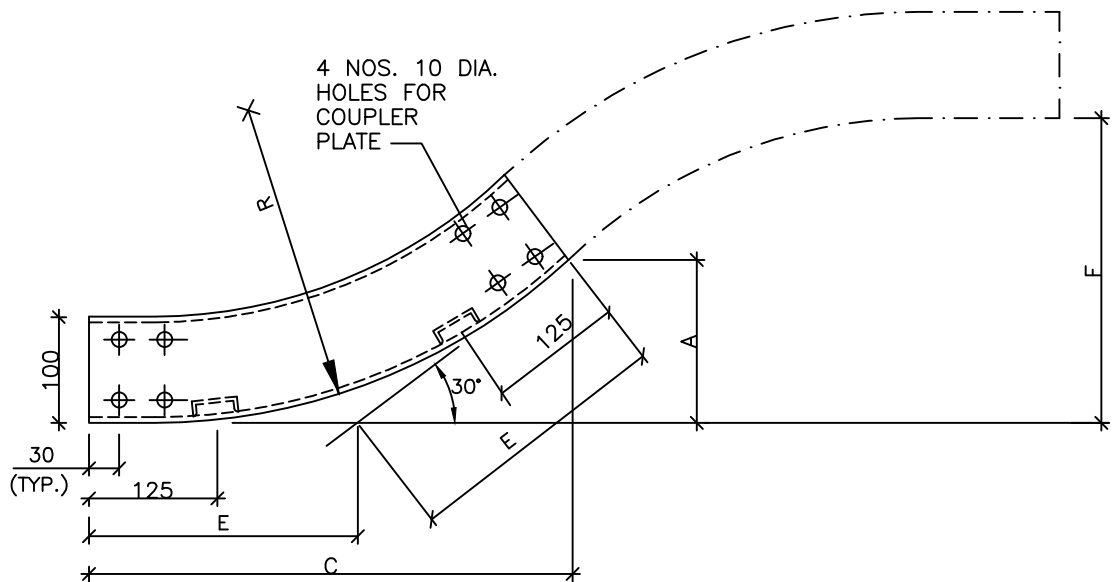
WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	205	285	755	1055	485
	600	145	225	530	830	365
	450	125	205	455	755	325
	300	105	185	380	680	285
450	1050	205	265	755	980	465
	600	145	205	530	755	345
	450	125	185	455	680	305
	300	105	165	380	605	265
300	1050	205	245	755	905	445
	600	145	185	530	680	325
	450	125	165	455	605	285
	300	105	145	380	530	245

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

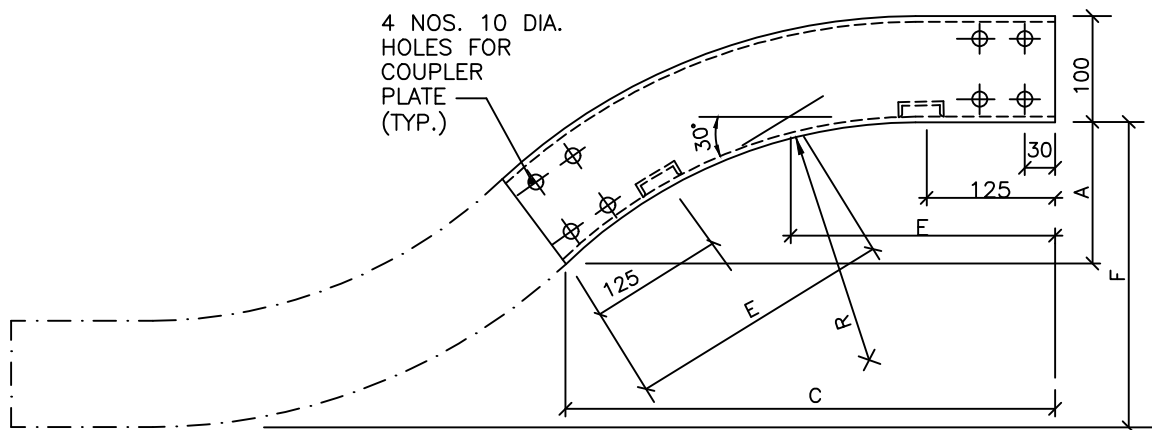
FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 07 OF 28 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



ELEVATION
30° VERTICAL ELBOW (INSIDE)

WIDTH(W)	RADIUS(R)	A	C	E	F
600	1050	205	760	410	410
450	600	145	535	290	290
&	450	125	460	250	250
300	300	105	385	210	210

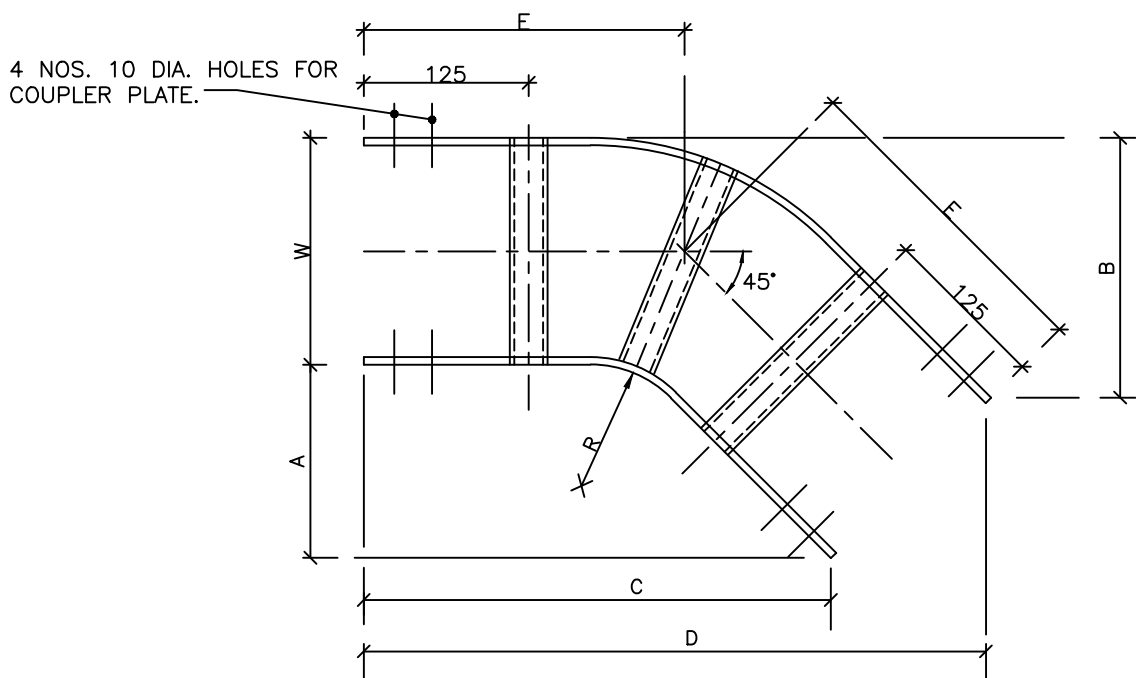


ELEVATION
30° VERTICAL ELBOW (OUTSIDE)

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY



PLAN
45° HORIZONTAL ELBOW

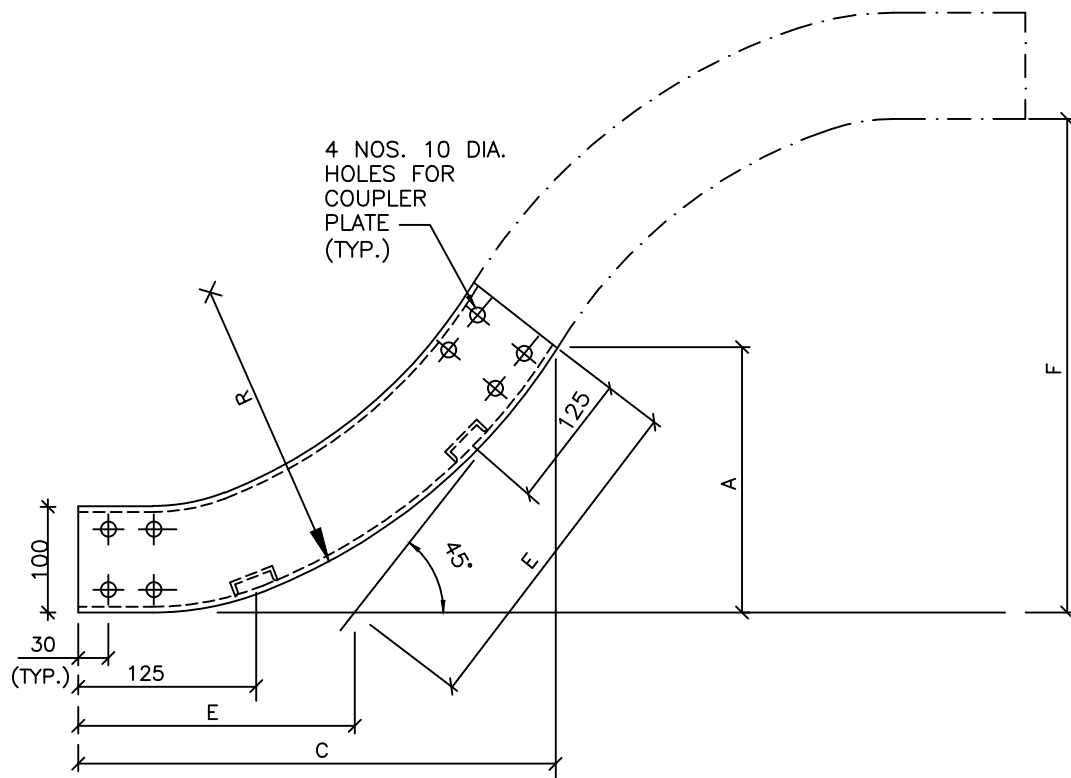
WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	395	570	955	1380	685
	600	265	440	640	1065	535
	450	220	395	530	955	470
	300	175	350	425	850	410
450	1050	395	530	955	1275	690
	600	265	395	640	955	500
	450	220	350	530	850	440
	300	175	310	425	745	390
300	1050	395	485	955	1165	655
	600	265	350	640	850	470
	450	220	310	530	745	410
	300	175	265	425	635	345

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

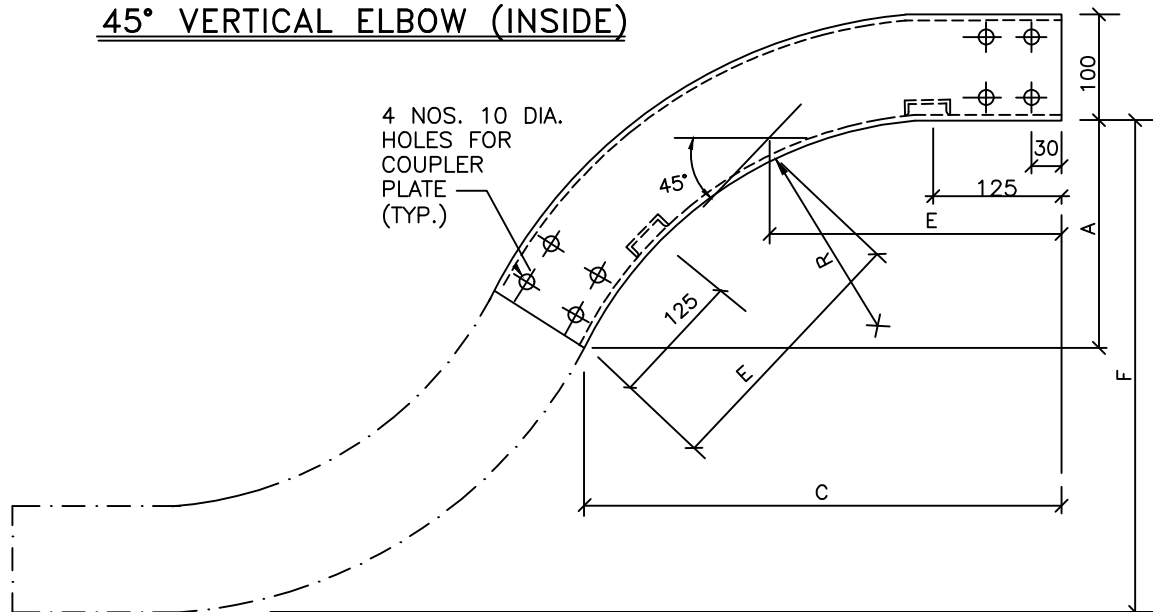
FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 09 OF 28	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE				



ELEVATION

45° VERTICAL ELBOW (INSIDE)



ELEVATION

45° VERTICAL ELBOW (OUTSIDE)

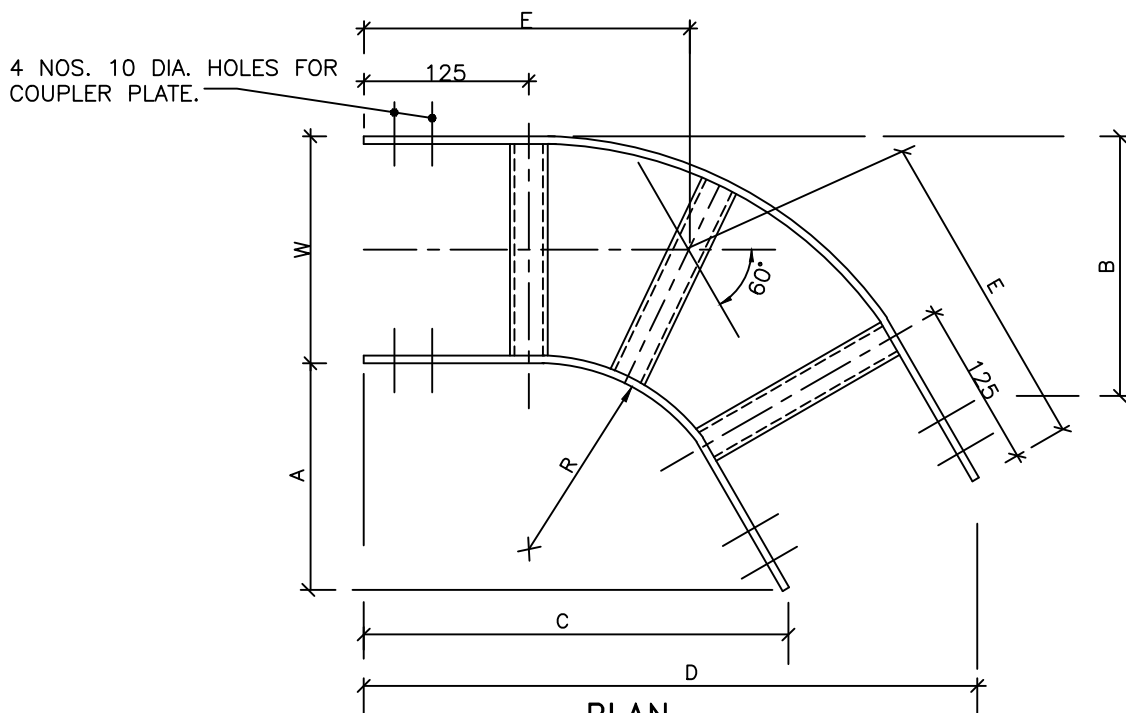
WIDTH(W)	RADIUS(R)	A	C	E	F
600	1050	395	955	560	790
450	600	265	640	375	530
&	450	220	530	310	440
300	300	175	425	250	350

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						 NLC TAMILNADU POWER LIMITED			
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 10 OF 28		REV. -



PLAN
60° HORIZONTAL ELBOW

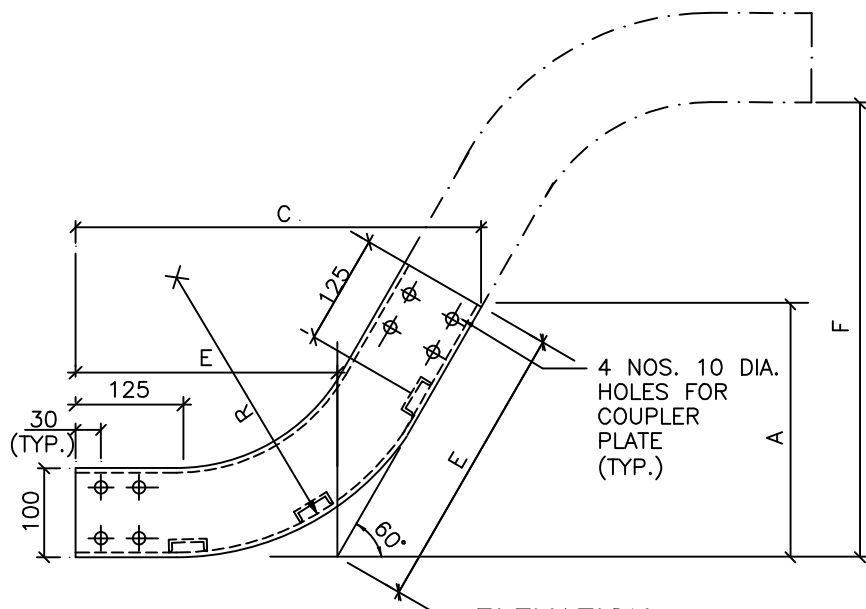
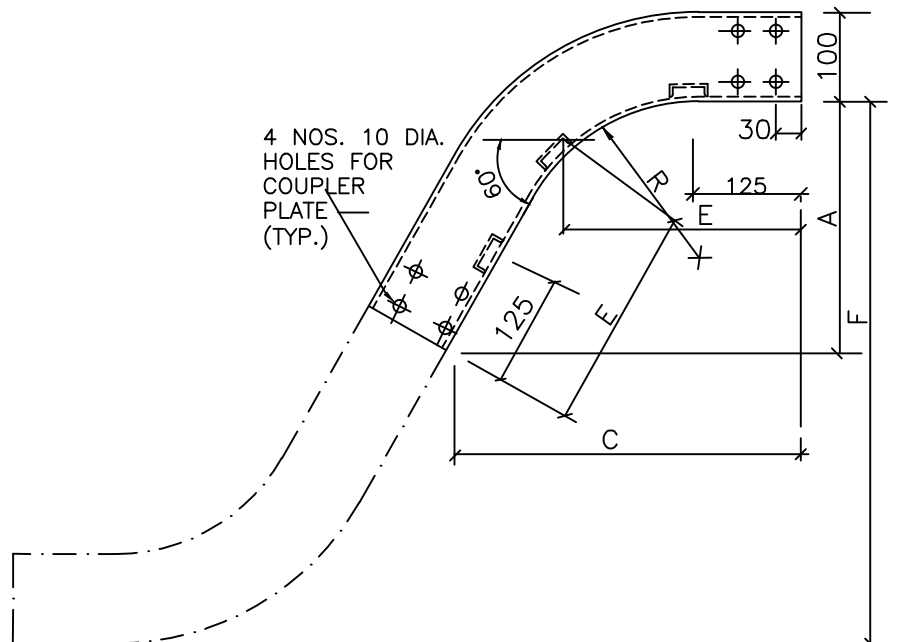
WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	635	935	1095	1615	905
	600	410	710	705	1225	645
	450	335	635	575	1095	560
	300	250	550	450	965	470
450	1050	635	860	1095	1485	860
	600	410	635	705	1095	600
	450	335	550	575	965	515
	300	250	485	450	835	425
300	1050	635	785	1095	1355	815
	600	410	560	705	965	555
	450	335	485	575	835	470
	300	250	410	450	705	385

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

					CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 11 OF 28	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

ELEVATION60° VERTICAL ELBOW (INSIDE)ELEVATION60° VERTICAL ELBOW (OUTSIDE)

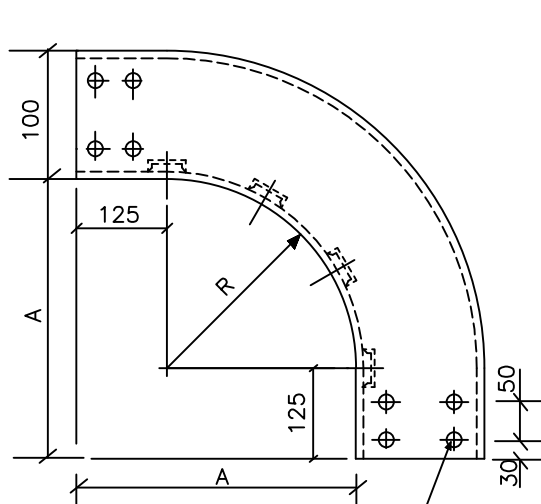
WIDTH(W)	RADIUS(R)	A	C	E	F
600	1050	635	1095	730	1270
450	600	410	705	470	820
&	450	335	575	385	670
300	300	260	450	300	520

NOTE :-

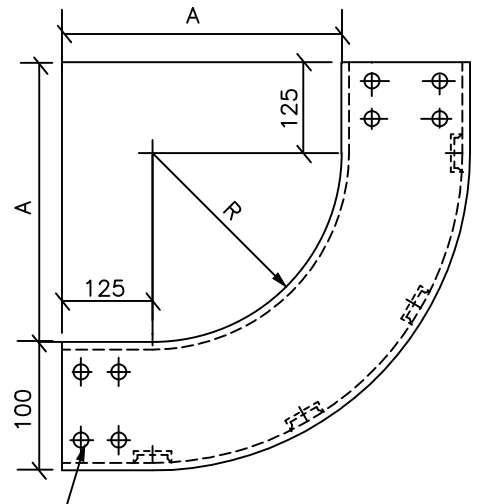
1. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 12 OF 28	REV.	-



ELEVATION
90° VERTICAL ELBOW
(OUTSIDE)

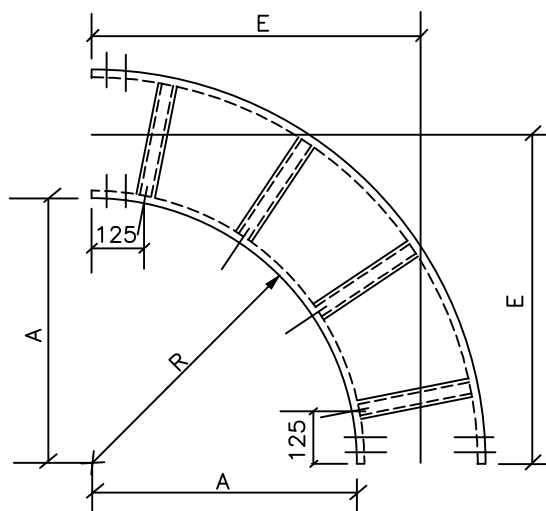


ELEVATION
90° VERTICAL ELBOW
(INSIDE)

4 NOS. 10 DIA. HOLES
FOR COUPLER PLATE

VERTICAL ELBOW		
WIDTH (W)	RADIUS (R)	A
600	1050	1175
450	600	725
& 300	450	575
	300	425

HORIZONTAL ELBOW			
WIDTH (W)	RADIUS (R)	A	E
600	1050	1175	1475
	600	725	1025
	450	575	875
	300	425	725
450	1050	1175	1400
	600	725	950
	450	575	800
	300	425	650
300	1050	1175	1325
	600	725	875
	450	575	725
	300	425	575



PLAN
90° HORIZONTAL ELBOW

NOTES :-

- ALL DIMENSIONS ARE IN MM.
- FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 13 OF 28	REV. -

PERFORATION
PUNCHED FROM
THIS SIDE

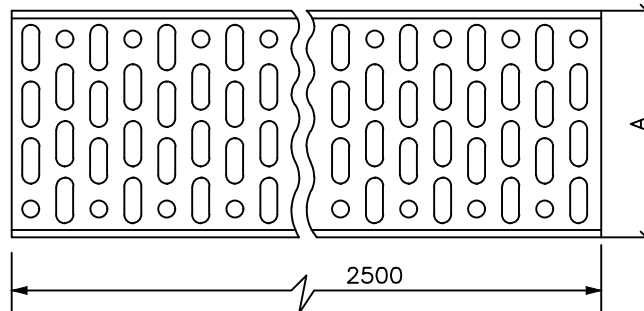
ADDITIONAL PERFORATIONS
REQUIRED ON 100, 225
& 300 MM WIDTH PLATES
ALONG LINES 'X' OR 'Y'

END ELEVATION

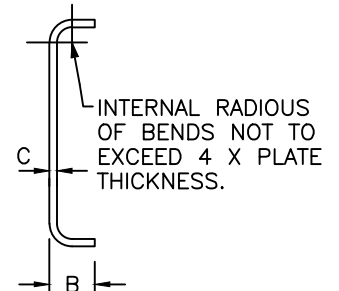
PLAN

90° HORIZONTAL ELBOW

DIMENSIONS IN MM	
WIDTH-A	DEPTH-B
100	50
150/225	
300	50

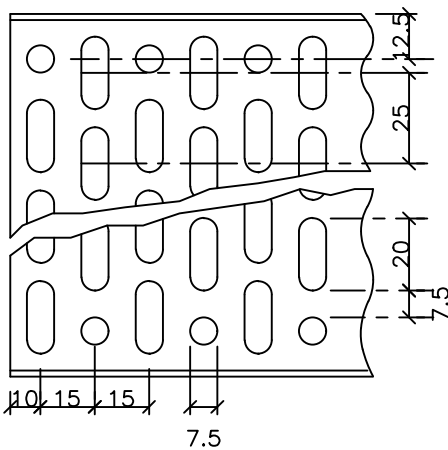


PLAN



END ELEVATION

STRAIGHT LENGTH



DETAILS OF PERFORATION

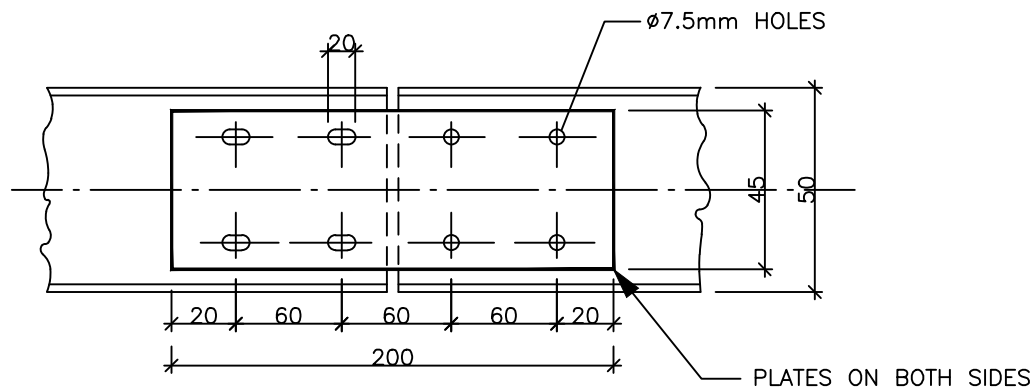
NOTES :

1. ALL CUTTING & FORMING OPERATIONS TO BE COMPLETED PRIOR TO GALVANIZING.
2. FINISHED TRAYS TO BE FREE FROM BURRS AND SHARP EDGES.
3. ALL DIMENSIONS ARE IN MM.

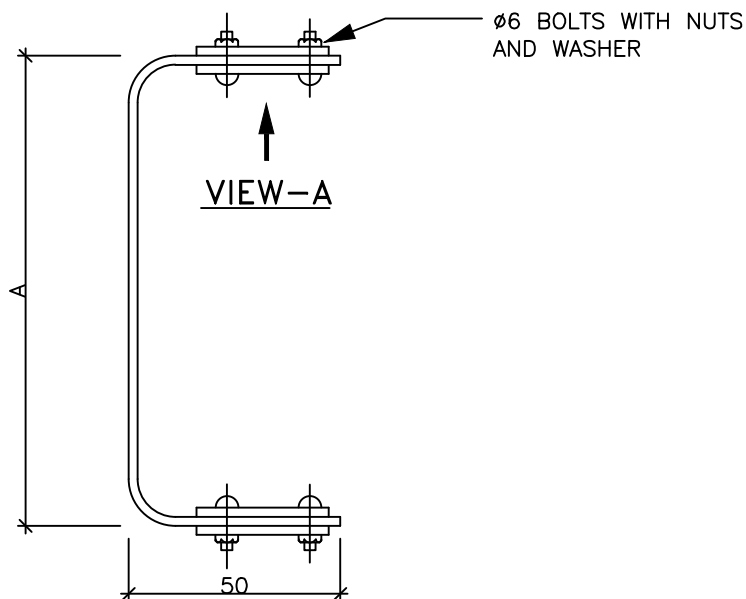
PERFORATED TYPE CABLE TRAY

FOR TENDER PURPOSE ONLY

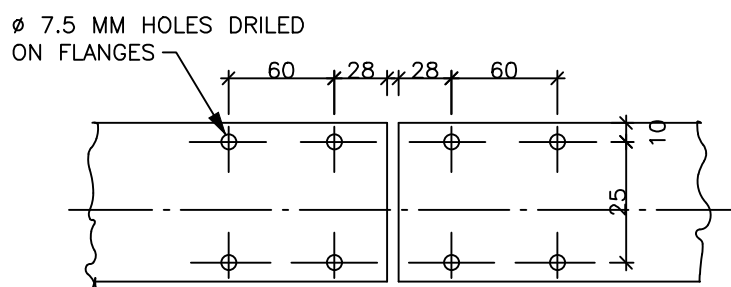
						CABLING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
						 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09		SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0400		REV.
APPVD.	REVWD.	CHKD.	REV.	DATE				SHT. 14 OF 28		-



VIEW-A



END ELEVATION



COUPLING PLATE

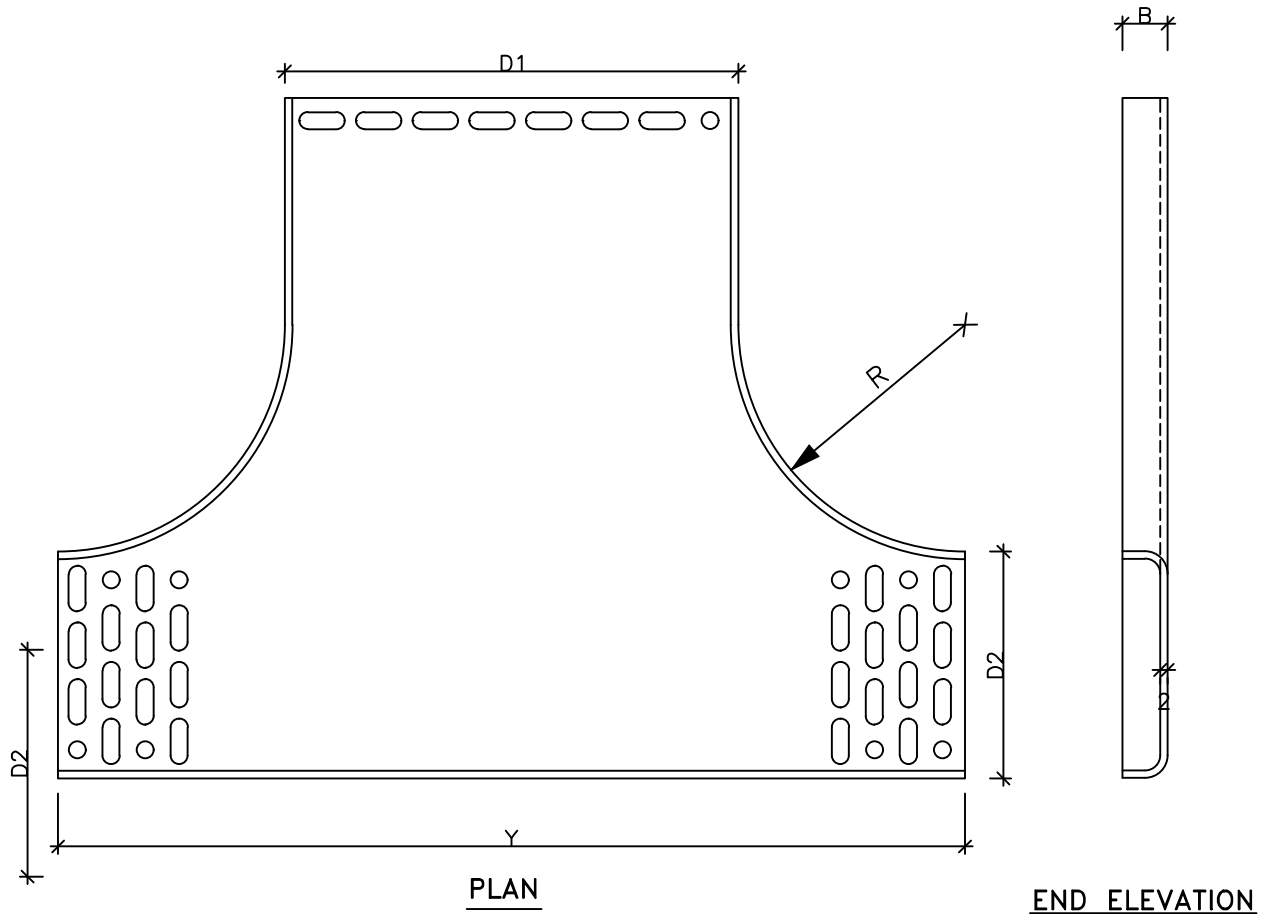
**PERFORATED TRAY JOINING BY
COUPLING PLATES**

NOTES:-

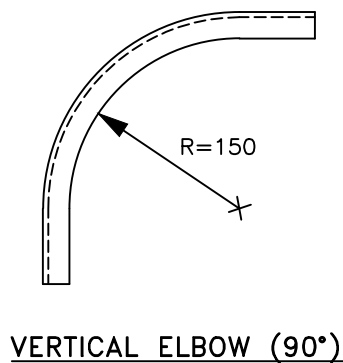
1. COUPLING PLATES 2 MM THICK M.S.
2. ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400		REV.
							SHT. 15 OF 28		-



HORIZONTAL TEE



TYPE	DIMENSIONS IN MM				
	D1	D2	B	R	Y
A	225	100	50	150	500
B	300	150	50	200	600

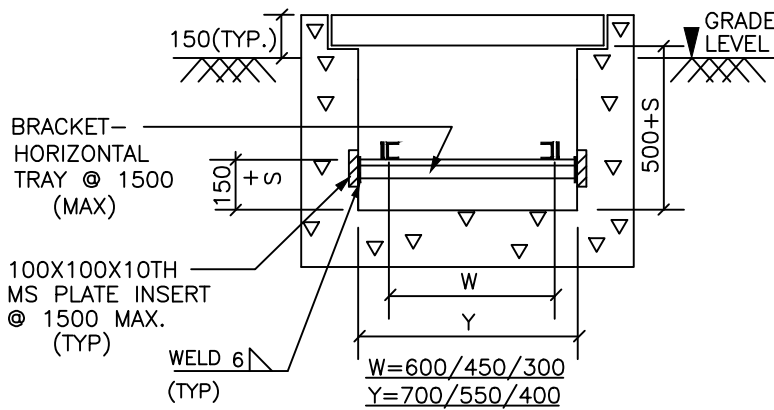
PERFORATED TRAY FITTINGS

FOR TENDER PURPOSE ONLY

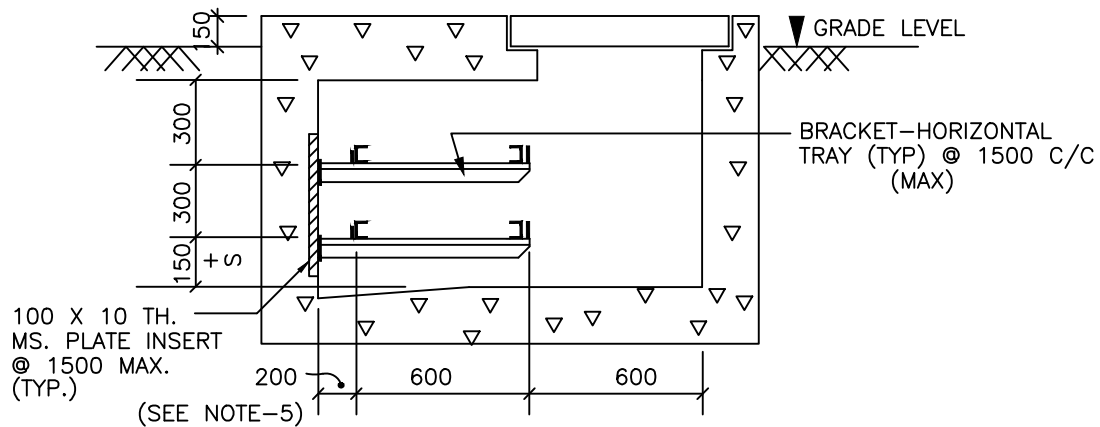
					 NLC TAMILNADU POWER LIMITED		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19				
APPVD.	REVWD.	CHKD.	REV.	DATE	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09 DWG. NO. 18A09-DWG-E-0400 SCALE : NTS SHT. 16 OF 28	

NOTES :-

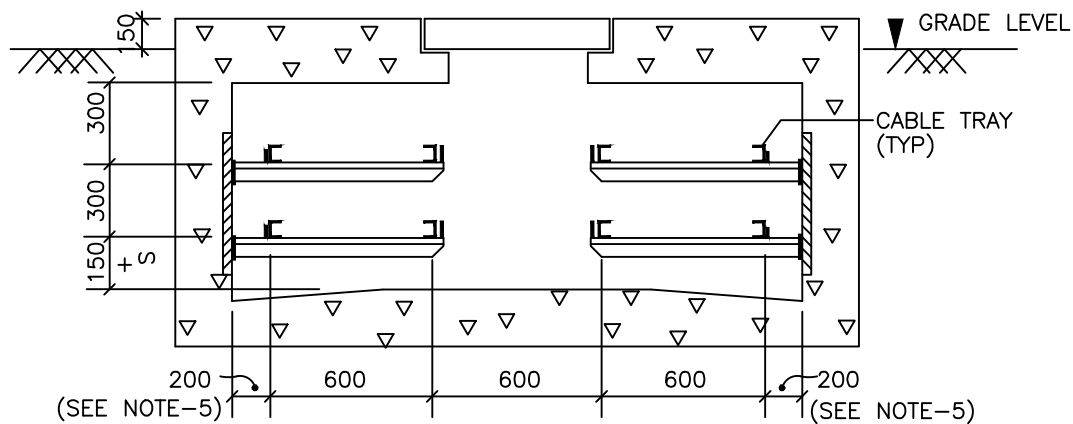
1. ALL DIMENSIONS ARE IN MM.
2. +S INDICATES DISTANCE TO MAINTAIN THE 'SLOPE' OF THE TRENCH.
3. MOUNTING ARRANGEMENT IN CABLE TRENCH TYPE-C,CC,DD ETC. SHALL BE SIMILAR.
4. FOR CABLE TRENCH GROUNDING REFER DWG.NO. K3A02 -DWG-E-0600.
5. FOR LONG TRENCH WITHOUT ANY INTERMEDIATE CABLE EXIT, THE GAP "200" MAY BE DISPENSED WITH. HOWEVER, THE SAME SHALL BE PROVIDED FOR AT LEAST 1500mm ON EITHER SIDE OF THE EXIT.



TR - A



TR - B



TR - BB

MOUNTING ARRANGEMENT (IN CABLE TRENCH)

FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 17 OF 28	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE				

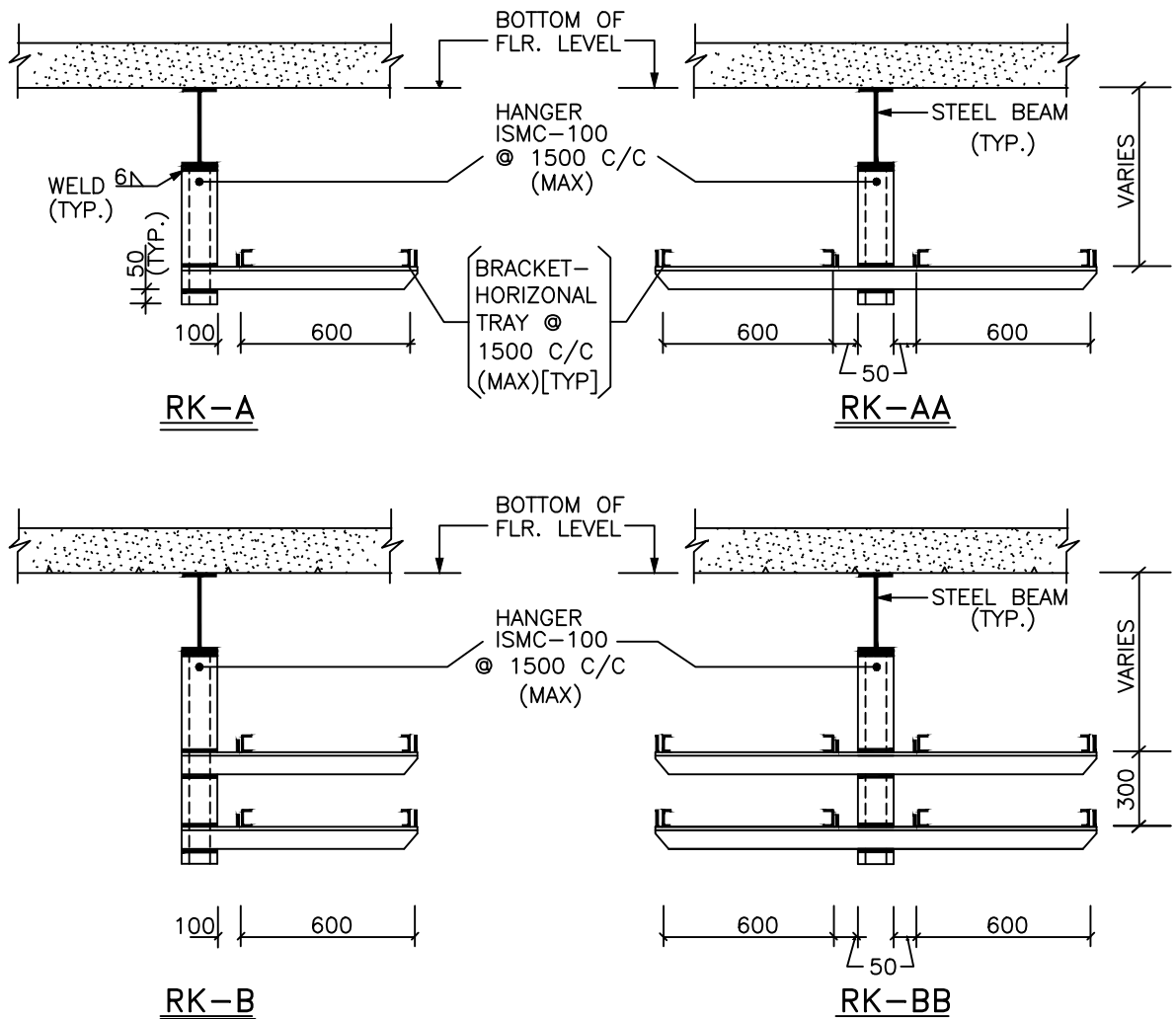


TABLE-1

RACK		NO. OF TIER
TYPE	WIDTH	
A1	450	1
B1	450	2
A2	300	1
B2	300	2

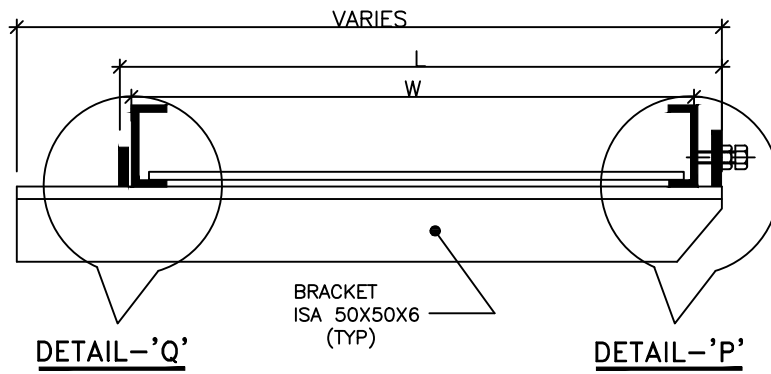
**MOUNTING ARRANGEMENT
(FROM BEAM)**

NOTES :-

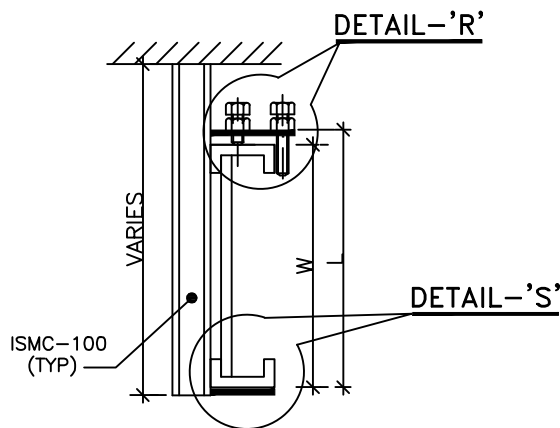
1. ALL DIMENSIONS ARE IN MM.
2. FOR OVERHEAD CABLE TRAY GROUNDING REFER DWG.NO. K3A02-DWG-E0600
3. FOR RACK TYPE RK-C, RK-CC, RK-D, RK-DD ETC. THE ARRANGEMENT SHALL BE SIMILAR.

FOR TENDER PURPOSE ONLY

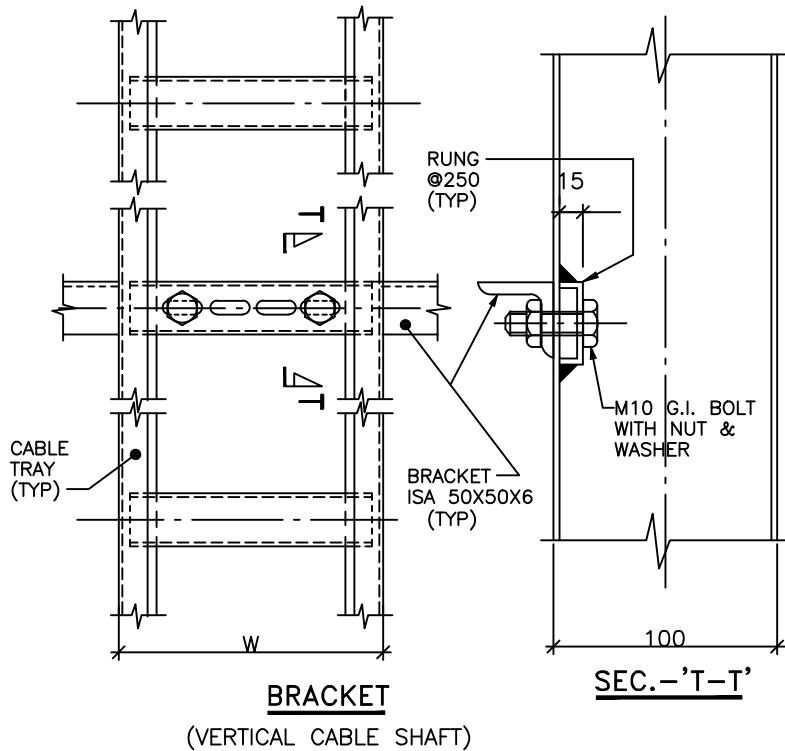
						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 18 OF 28 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



BRACKET
(HORIZONTAL CABLE TRAY)

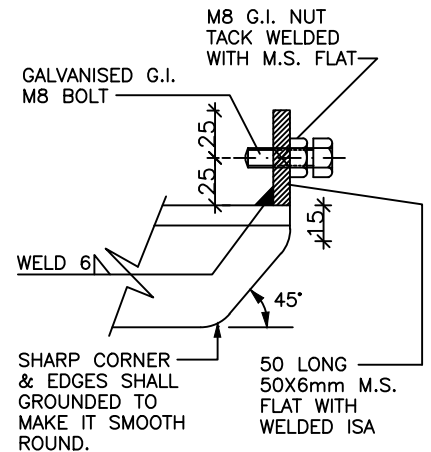


BRACKET
(VERTICAL CABLE TRAY)

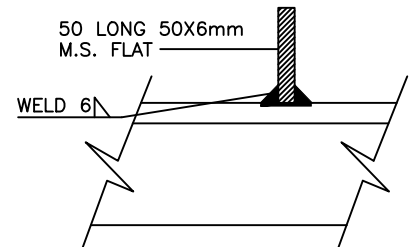


BRACKET
(VERTICAL CABLE SHAFT)

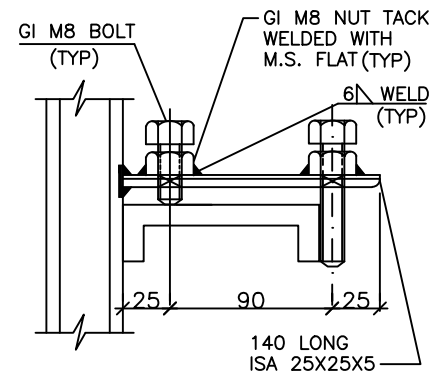
W	600	450	300
L	625	475	325



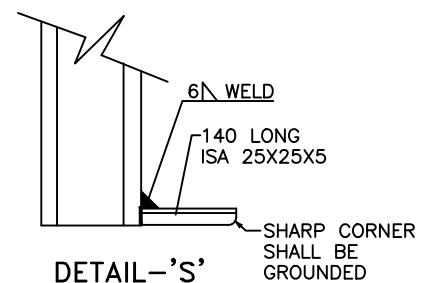
DETAIL-'P'



DETAIL-'Q'



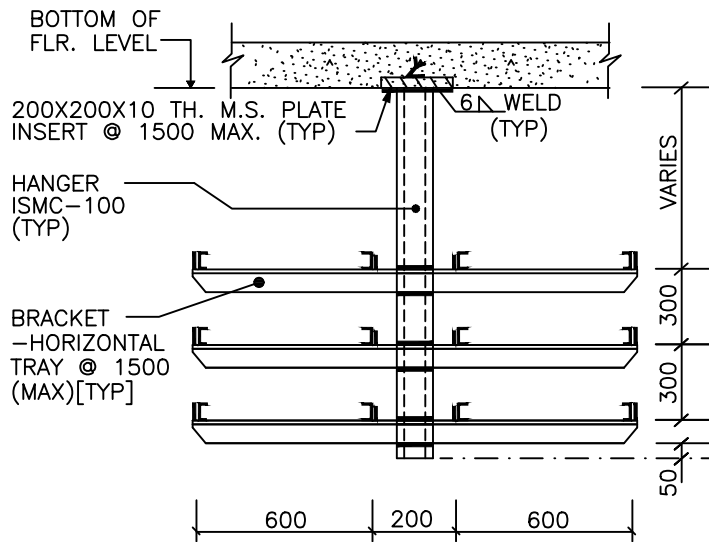
DETAIL-'R'



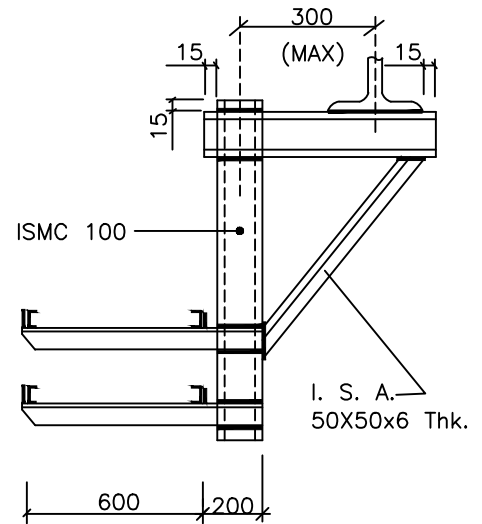
DETAIL-'S'

FOR TENDER PURPOSE ONLY

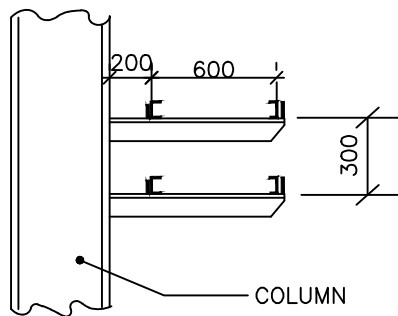
						CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 19 OF 28 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



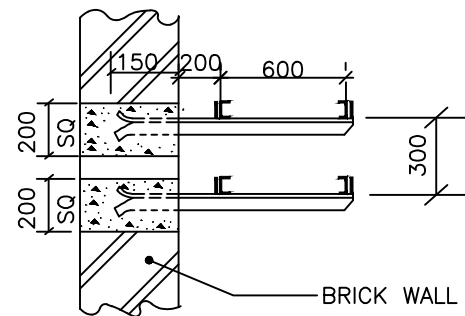
MOUNTING ARRANGEMENT
(FROM CEILING)



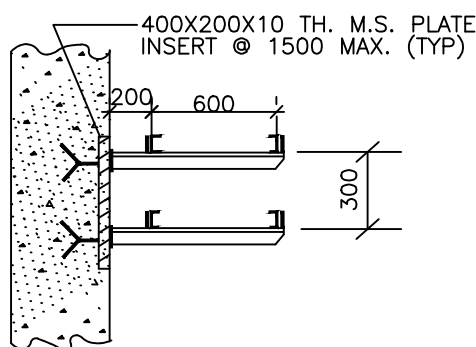
MOUNTING ARRANGEMENT
(FROM FLOOR BEAM)



MOUNTING ARRANGEMENT
(FROM STEEL COLUMN)



MOUNTING ARRANGEMENT
(FROM BRICK WALL)



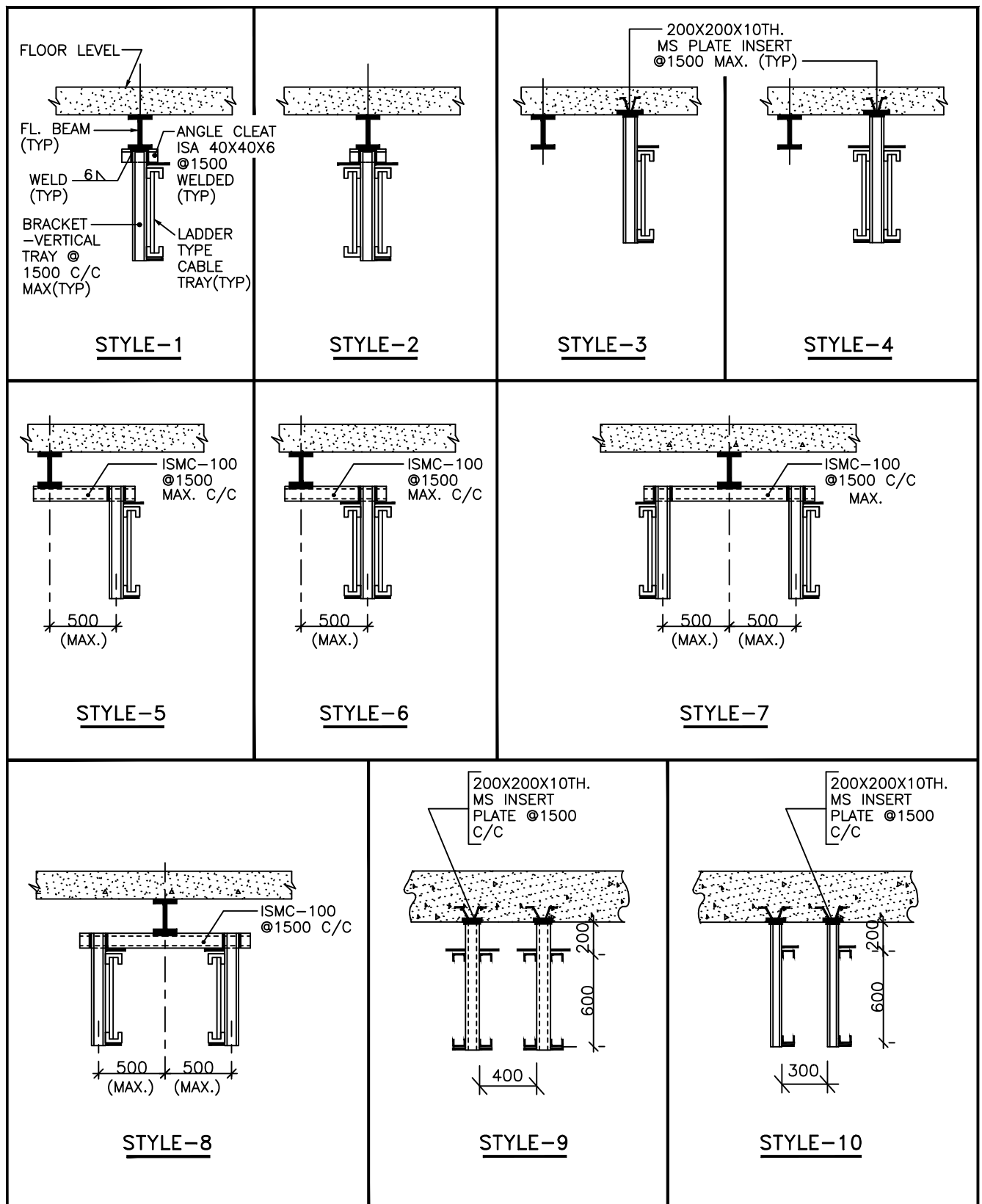
MOUNTING ARRANGEMENT
(FROM CONCRETE COLUMN)

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. THE NOS. OF TIER AND WIDTH OF EACH TRAY SHALL BE AS PER RACK TYPE NOS.
3. FOR OVERHEAD CABLE TRAY GROUNDING REFER DWG.NO. K3A14-DWG-E-0600

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	JOB NO. 18A09		SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0400				REV.
APPVD.	REVWD.	CHKD.	REV.	DATE			SHT. 20 OF 28				-

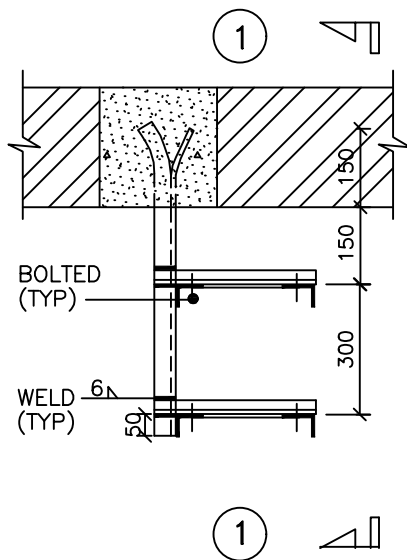


MOUNTING ARRANGEMENT

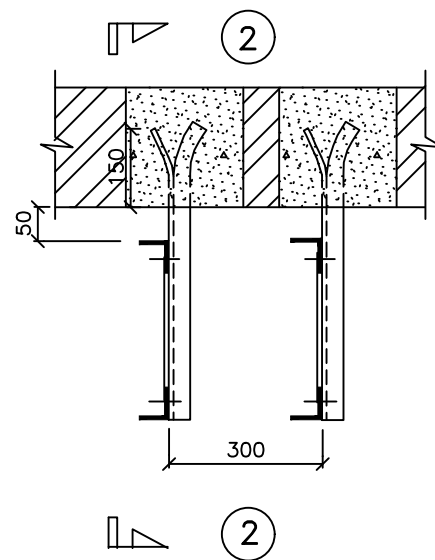
(VERTICAL CABLE TRAY)

FOR TENDER PURPOSE ONLY

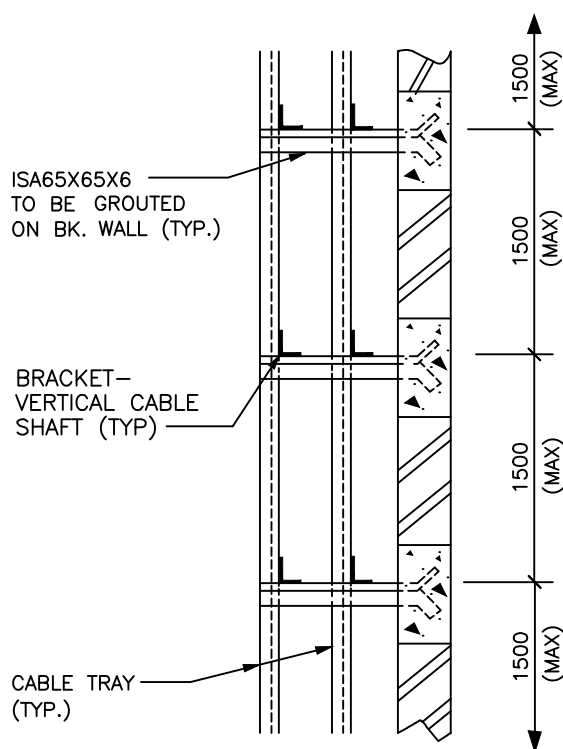
						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	JOB NO. 18A09		SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0400 SHT. 21 OF 28				REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE							



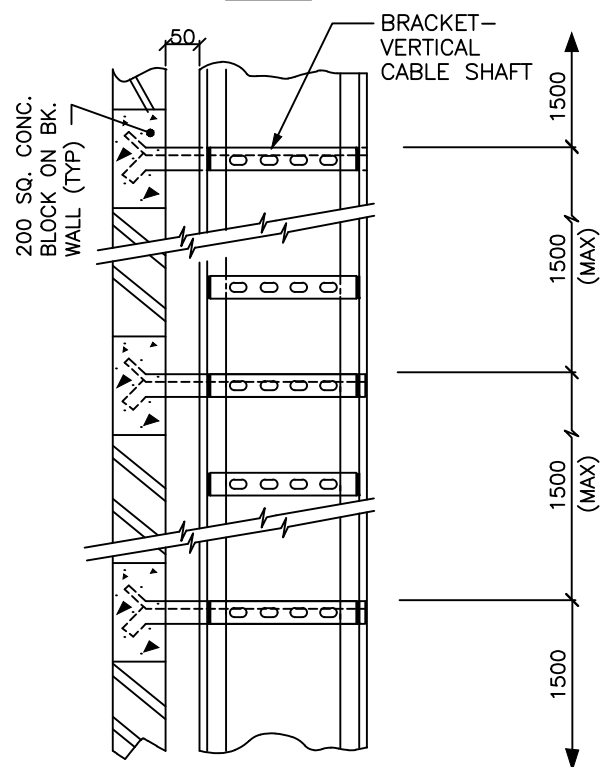
**PLAN
ALT.1**



**PLAN
ALT.2**



SEC:1-1



SEC:2-2

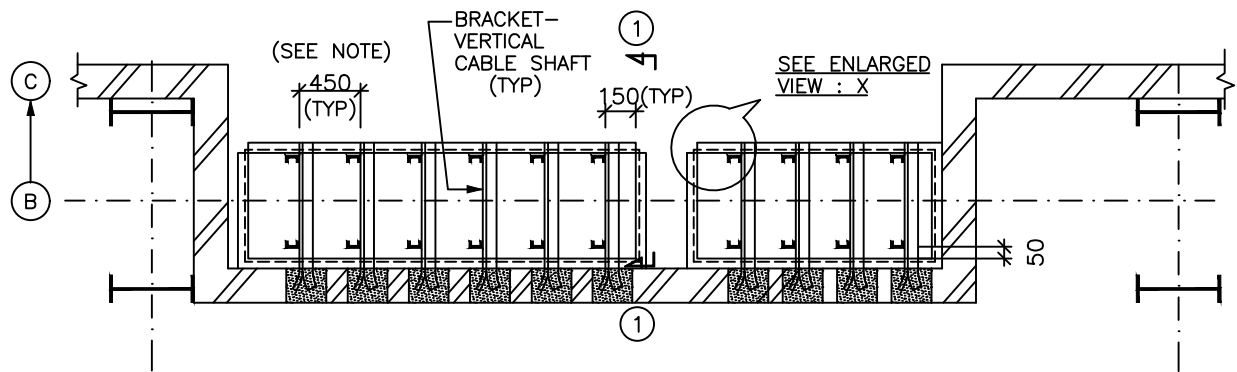
**MOUNTING ARRANGEMENT
(CABLE SHAFT ON BRICKWALL)**

NOTE

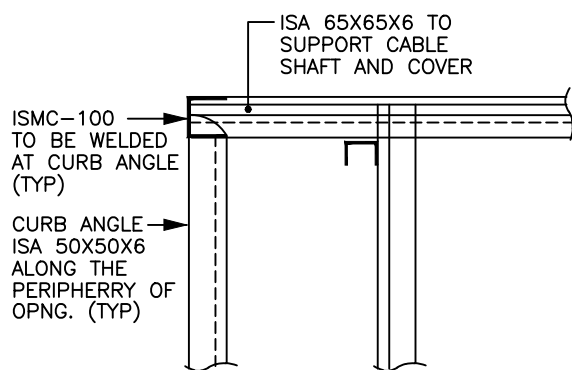
FOR CABLE SHAFT OF TYPE SH.-A, SH.-C, THE ARRANGEMENT SHALL BE SIMILAR TO SH.-B SHOWN HERE IN.

FOR TENDER PURPOSE ONLY

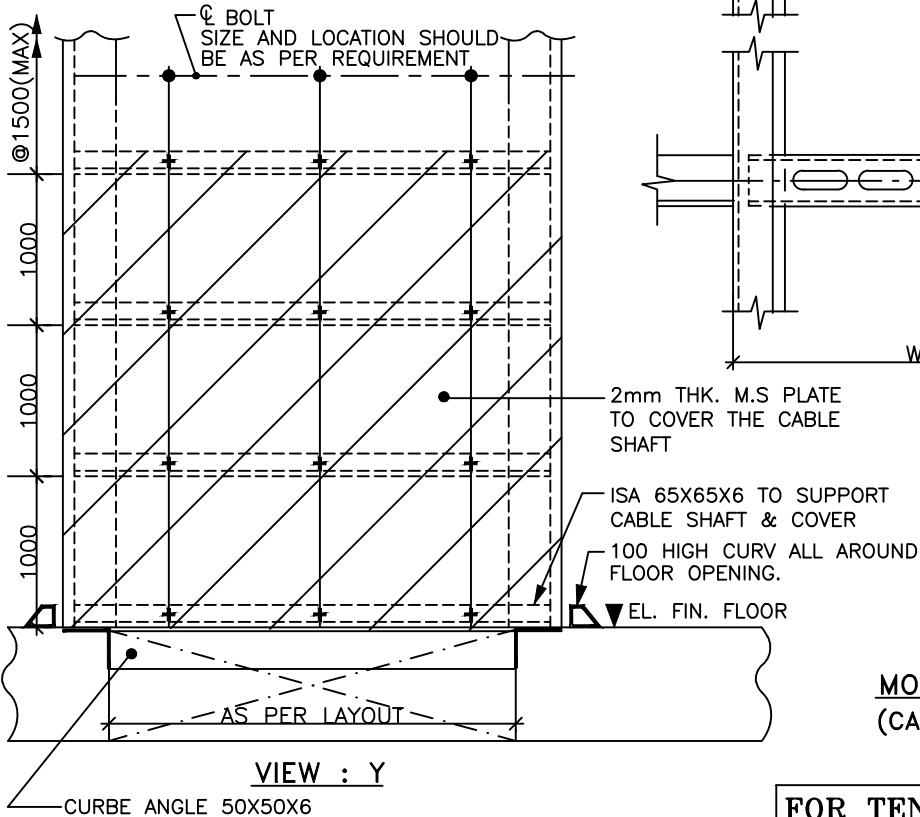
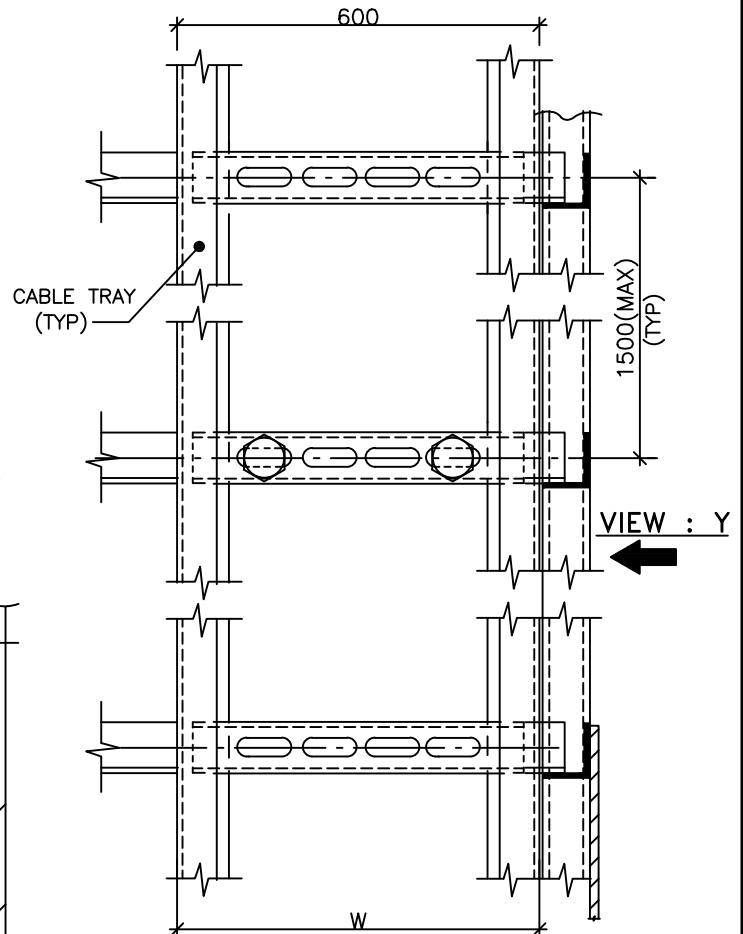
					CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0400	REV.
						SHT. 22 OF 28	-



PLAN AT EL.3.5M



ENLARGED VIEW : X
TYPICAL DETAILS OF CABLE SHAFT



NOTE:-

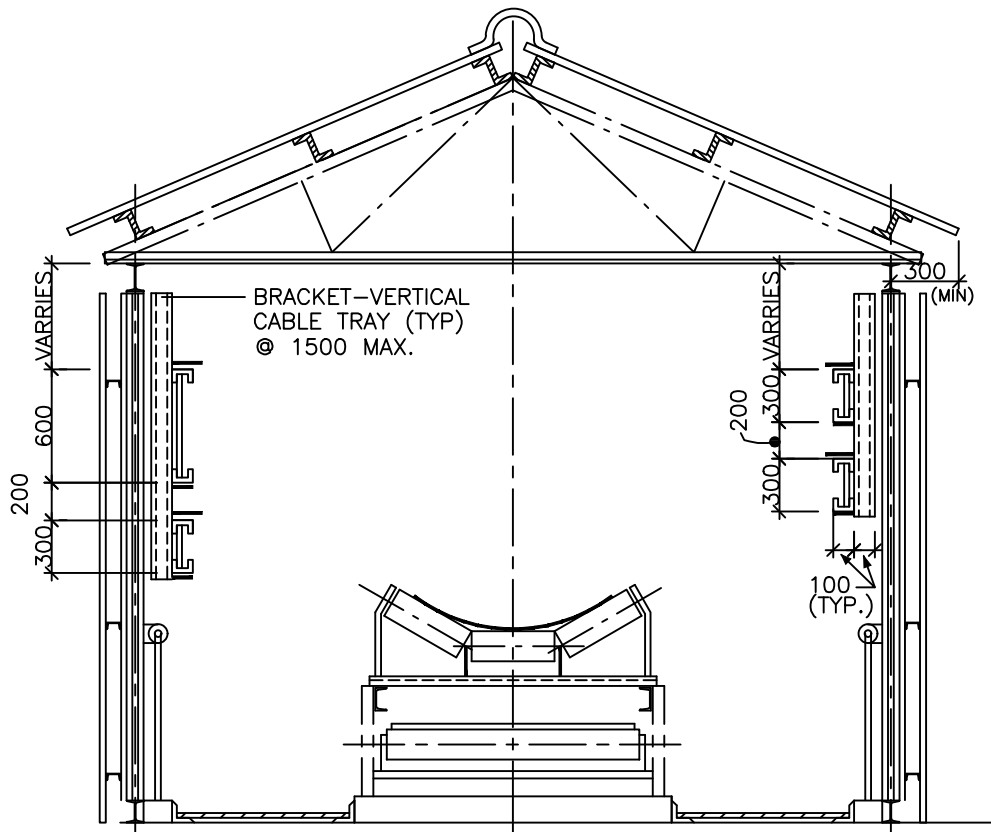
THE SPACING MAY BE REDUCED TO 300, IF CABLE TRAY IS APPLICABLE FROM BOTH SIDE.

**MOUNTING ARRANGEMENT
(CABLE SHAFT MAIN PLANT)**

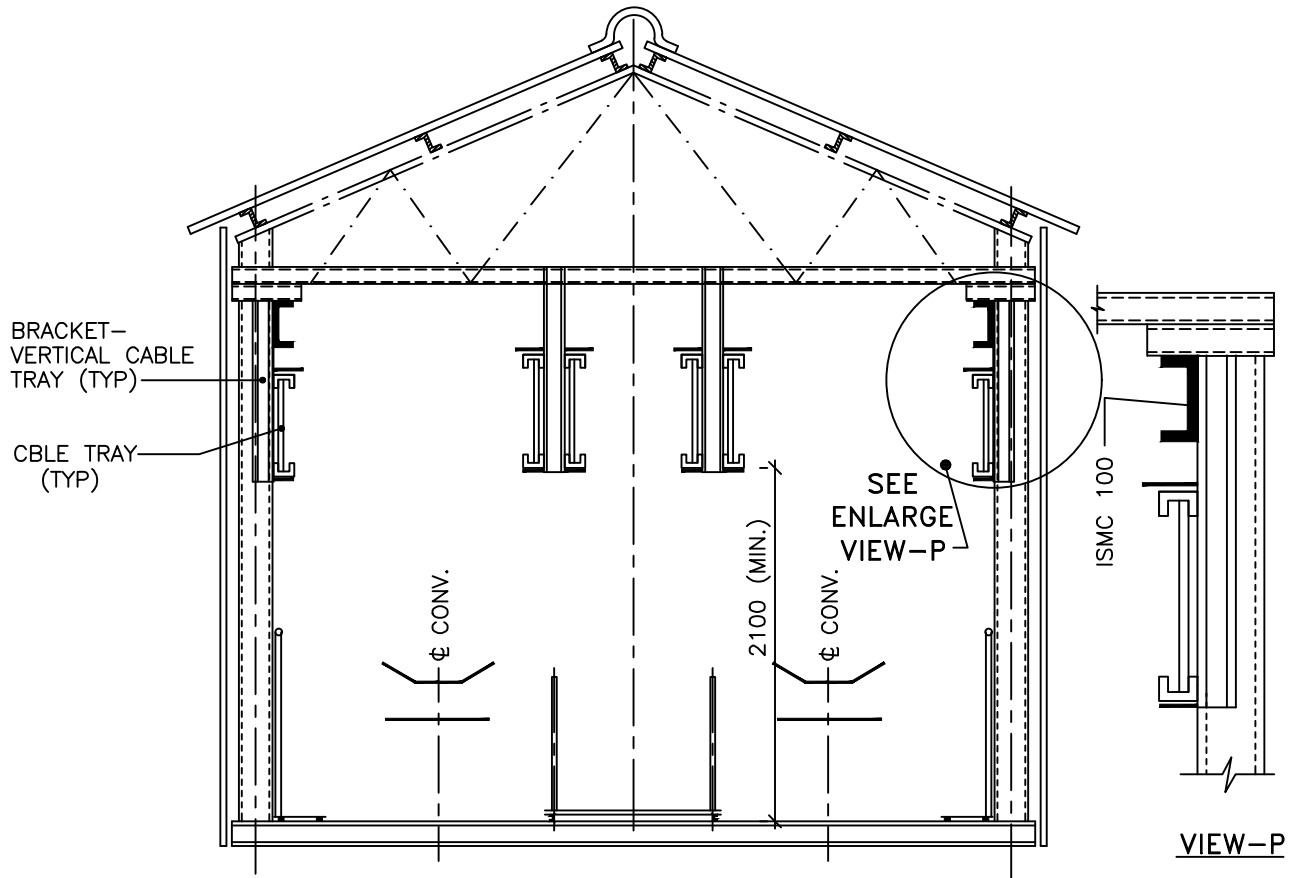
FOR TENDER PURPOSE ONLY

18A09-DWG-E-0400 Sh. 23 OF 28 12.02.2019

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400		REV.
							SHT. 23 OF 28		-



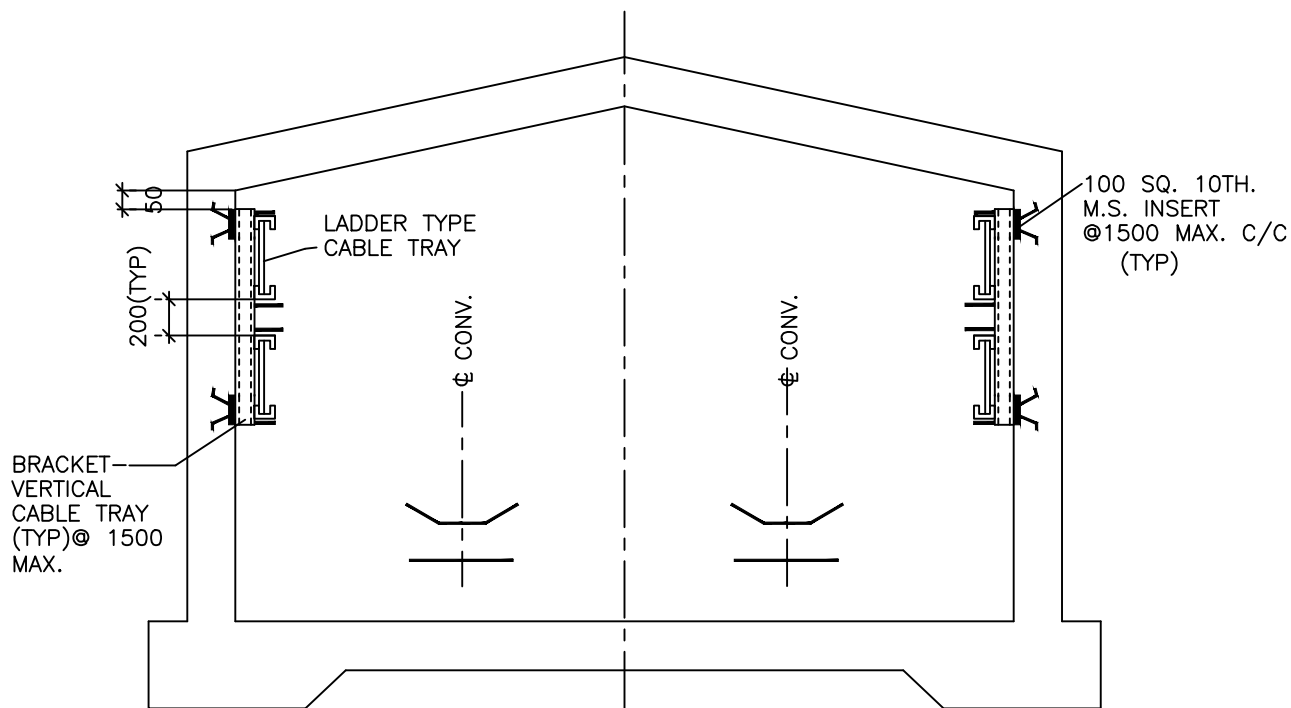
MOUNTING ARRANGEMENT
(INSIDE CONV. GALLERY-ALT-I)



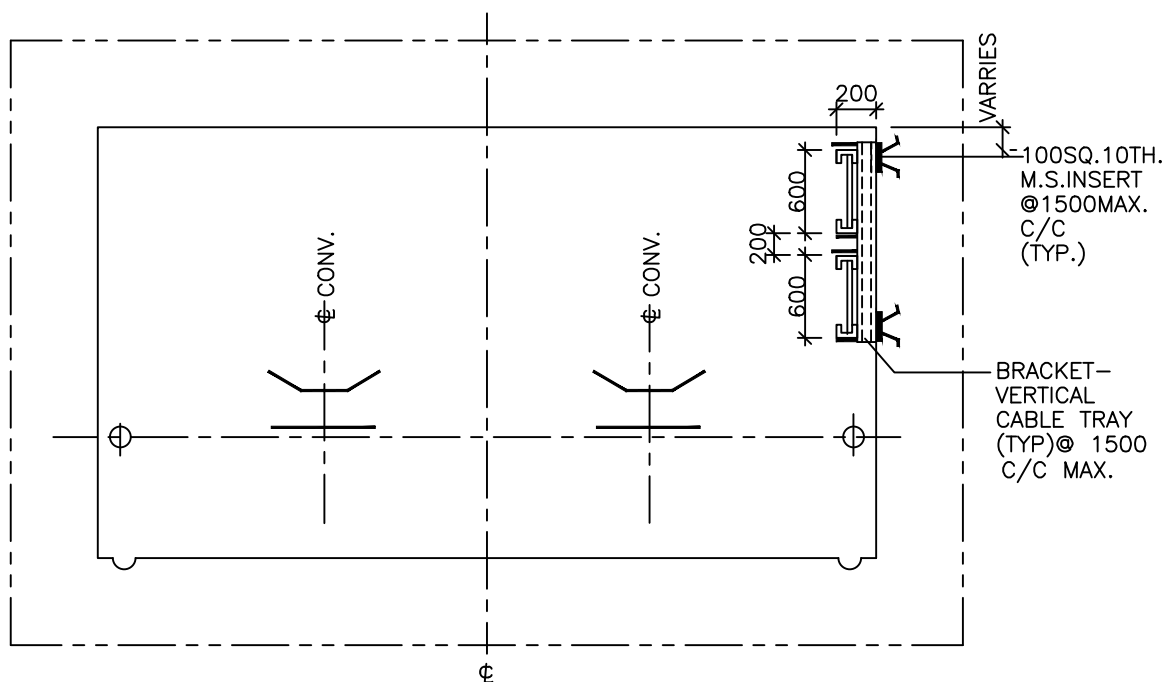
MOUNTING ARRANGEMENT
(INSIDE CONV. GALLERY-ALT-II)

FOR TENDER PURPOSE ONLY

						CABLING NOTES & DETAILS			DEVELOPMENT CONSULTANTS PVT. LTD.	
						NLC TAMILNADU POWER LIMITED			CONSULTING ENGINEERS	
							2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
DS	SM	BG	-	12.02.19				DWG. NO. 18A09-DWG-E-0400		REV.
APPVD.	REVWD.	CHKD.	REV.	DATE				SHT. 24 OF 28		-



MOUNTING ARRANGEMENT
(IN CONVEYOR TUNNEL-ALT-I)



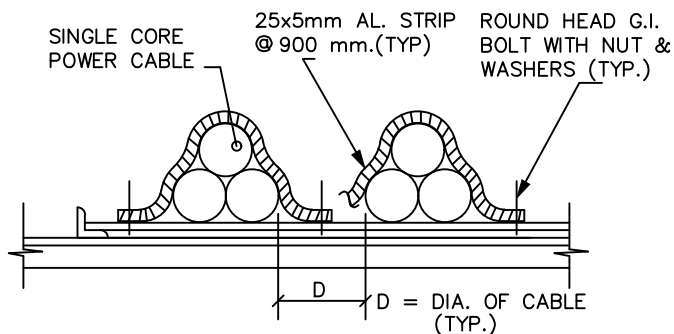
MOUNTING ARRANGEMENT
(IN CONVEYOR TUNNEL-ALT-II)

NOTE:-

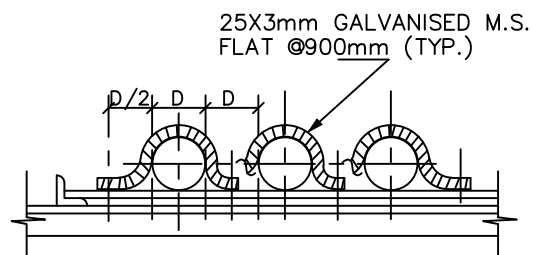
ALL DIMENSIONS ARE IN MM.

FOR TENDER PURPOSE ONLY

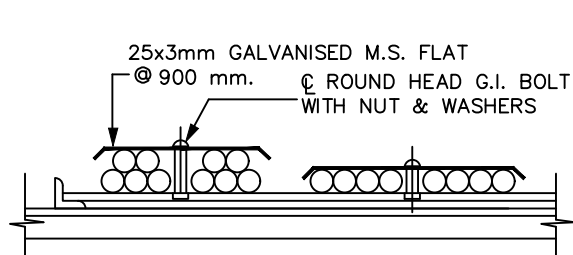
					CABLING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0400 SHT. 25 OF 28 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE		



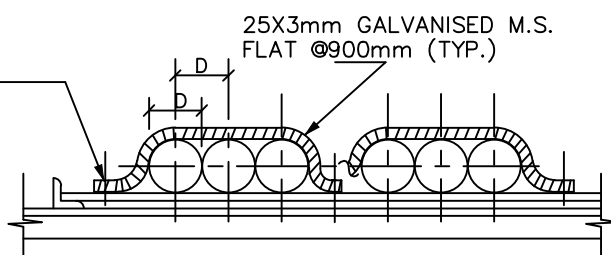
**CABLE CLAMPS IN TREFOIL FORMATION
FOR SINGLE CORE POWER CABLES**



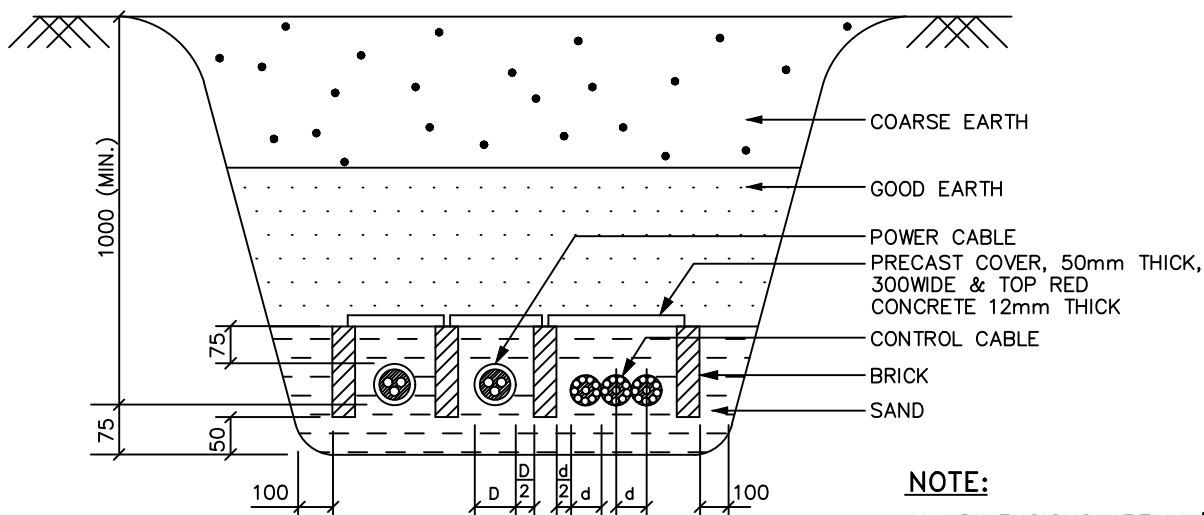
**CABLE CLAMPS FOR
MULTICORE POWER CABLES
(NOT TOUCHING EACHOTHER)**



**CLAMPING ARRANGEMENT
OF CONTROL CABLES**



**CABLE CLAMPS FOR
MULTICORE POWER CABLES
(TOUCHING EACHOTHER)**



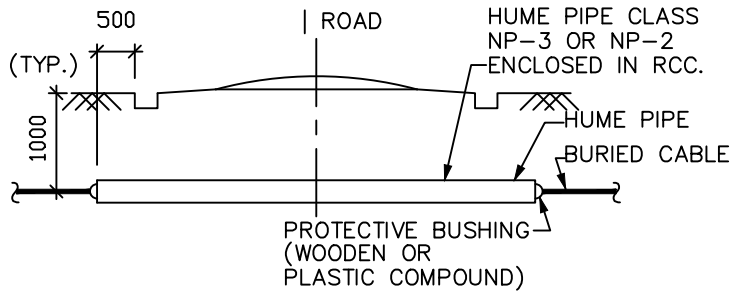
BURIED CABLE LAYING DETAILS

NOTE:

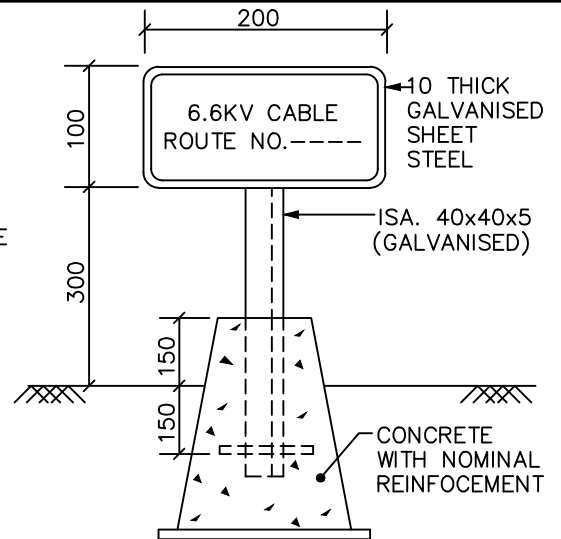
ALL DIMENSIONS ARE IN 'MM'.

FOR TENDER PURPOSE ONLY

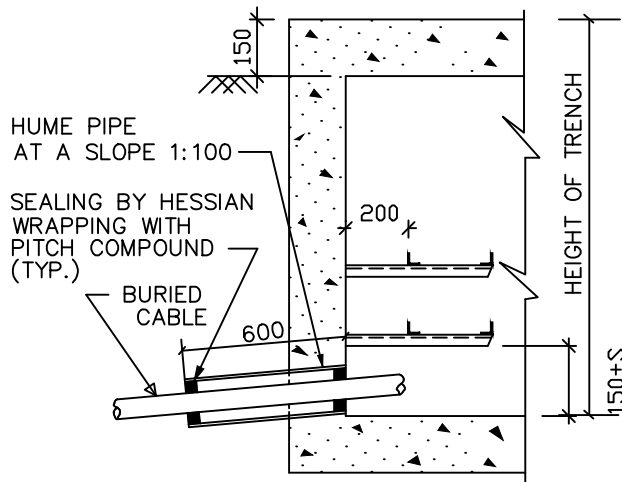
						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
								JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0400		REV.
APPVD.	REVWD.	CHKD.	REV.	DATE			SHT. 26 OF 28		-



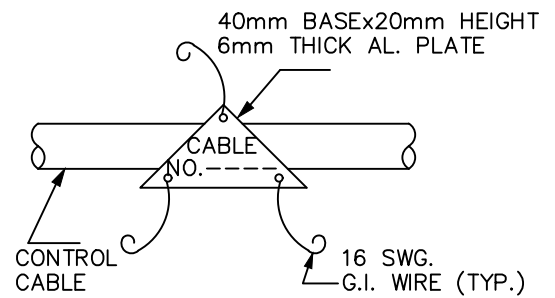
**ROAD CROSSING
OF BURIED CABLE**



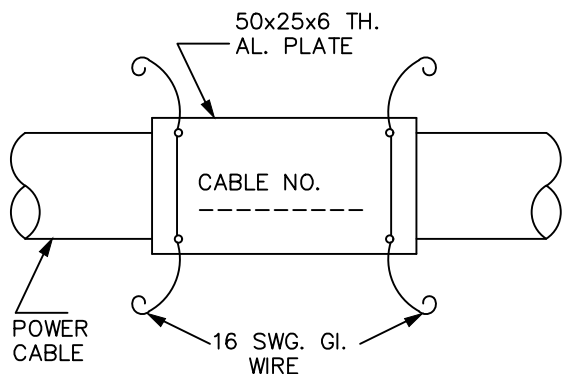
**CABLE ROUTE MAKER
(VOLTAGE TO BE MARKED)**



**TYP. DETAILS OF BURIED CABLE
ENTRY TO BLDG. OR CABLE TRENCH**



**CABLE TAG
CONTROL CABLE**



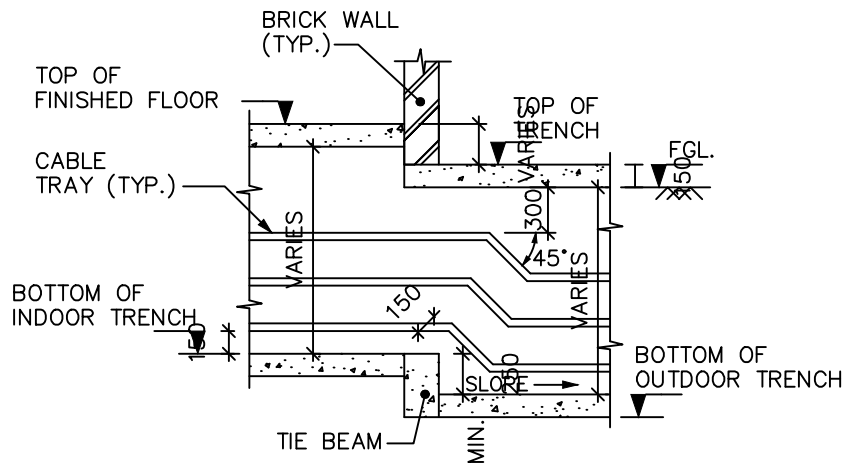
**CABLE TAG
POWER CABLE**

NOTE:

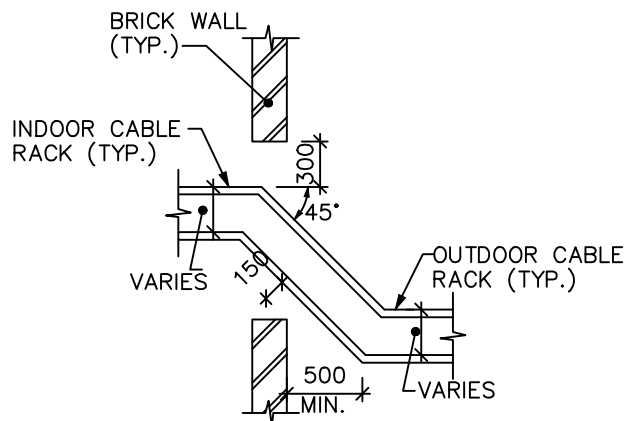
ALL DIMENSIONS ARE IN 'MM'.

FOR TENDER PURPOSE ONLY

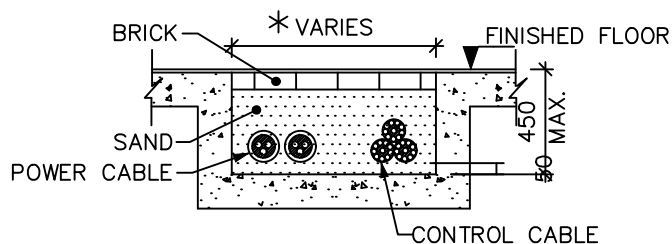
						CABLING NOTES & DETAILS			DEVELOPMENT CONSULTANTS PVT. LTD.	
						NLC TAMILNADU POWER LIMITED			CONSULTING ENGINEERS	
							2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
DS	SM	BG	-	12.02.19				DWG. NO. 18A09-DWG-E-0400		REV.
APPVD.	REVWD.	CHKD.	REV.	DATE				SHT. 27 OF 28		-



**TYPICAL DETAILS OF CABLE TRENCH
ENTRY TO BUILDING**



**TYPICAL DETAILS OF CABLE RACK
ENTRY TO BUILDINGS**



**CABLE LAYING IN SHALLOW TRENCH
(INDOOR)**

NOTE:

1. ALL DIMENSIONS ARE IN 'MM'.
2. THE PORTION OF FLOOR ABOVE THE TRENCH MARKED * SHALL BE FINISHED WITH WEAK MORTER.

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	  DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0400 SHT. 28 OF 28	REV. -

GROUNDING
NOTES & DETAILS

DWG. NO. 18A09-DWG-E-0600

FOR TENDER PURPOSE ONLY

GROUNDING NOTES

- 1.0 These grounding notes and details shall be read and construed in conjunction with grounding drawings and specification.
- 2.0 The grounding installation work shall conform to the requirements of the Indian Electricity Rules and code of Practice for Earthing (IS:3043) as amended up-to-date in India. For the work in other country, the statutory rules and code of practice in vogue there in shall be followed.
- 3.0 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below grade. A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trench/foundation/underground pipe at the crossing.
- 4.0 Ground grid conductors around a building/switchyard fence shall be buried outside the boundary at a minimum distance of 1200 mm.
- 5.0 A additional grid of 1500 mm x 1500 mm comprising of closely spaced (300 mmx300 mm) conductor at a depth of 300 mm from finished grade level shall be provided below the operating handle of Isolators Earth switches and Circuit Breaker operating boxes located in outdoor HV/EHV substation. This grid shall be connected to the main ground grid. The ground connection to operating handle shall be made of flexible connection.
- 6.0 The ground grid conductor below grade shall be of bare 40mm Ø mild steel rod. Ground electrode shall be 40mm Ø x 3000 mm long mild steel rod, driven into the ground and connected to the ground grid conductor.
- 7.0 Riser/pigtail from the ground grid shall be 40mm Ø mild steel rod and shall project 300 mm above grade/concrete floor level unless otherwise shown.
- 8.0 All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Bending of the conductor where necessary shall be done by gas heating.
- 9.0 Above grade, 50 x 6 mm galvanised mild steel flats shall be run as main ground conductors along building steels, walls and cable trays and securely fixed to the same by welding/clamping at intervals not exceeding 1500 mm.
The ground conductors shall be interconnected between them and to the main ground grid through risers.

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 01 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

10. All electrical equipment and associated non-current carrying metal works, supporting structures, building/boiler columns, fence, system neutrals, lighting masts/arresters shall be connected to the plant ground system.
11. Two separate and distinct ground connections shall be provided for grounding of electrical equipment frameworks.
12. Miscellaneous devices such as junction boxes, pull boxes, push-button stations, lockout switches, cable end boxes etc. shall be effectively grounded whether specifically shown or not.
13. Ground conductor connections above grade shall be generally made by electric arc welding. The connection shall be coated with cold galvanising/weather resistant paints.
14. Bolted connection shall be made only for grounding of equipment/ devices and some removable structures. The contact surfaces shall be thoroughly cleaned before connection to ensure good electrical contact.
15. A continuous 50 x 6 mm galvanised M.S flat ground conductor shall be installed along the cable raceway and securely attached to each tray section, forming a solidly grounded tray system.
16. A 16 Swg G.I. wire shall be run along the metallic conduit and shall be securely tied with the same at an interval 300 mm.
Grounding connection or wire jumpers shall be installed where flexible conduit is used to connect rigid conduit to equipment.
17. Crane rails shall be grounded at both ends. in addition all joints shall be bonded to provide electrical continuity.
18. Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten(10) meters. Fence gate shall be separately grounded with flexible connection to permit movement.
19. For shielding, the ground conductors shall be taken right upto the top along the structure/chimney and connected directly to the lightning masts.
20. The poles used for distribution line and / or street light shall be grounded at the bottom.

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 02 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

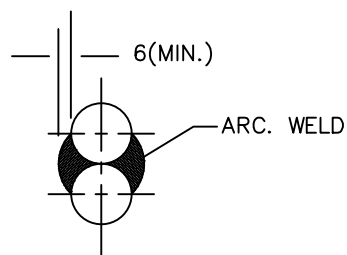
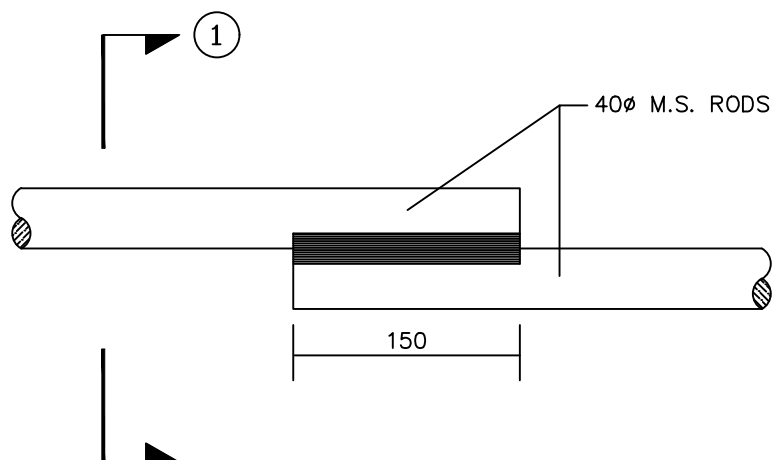
21. Ground electrodes shall be provided at connections with generator/ transformer neutrals, lightning arresters and lightning masts.

22. For ground connections, the conductor sizes shall be as listed below :-

Equipment		Galvanised mild steel flats
a. 400 KV and EHV equipment	:	50 x 6 mm
b. 11 kv, 3.3 KV equipment	:	50 x 6 mm
c. Structures, Cable trays etc.	:	50 x 6 mm
d. 415 V, P.C.C., M.C.C. etc.	:	50 x 6 mm
e. Motors above 90 KW, control panels	:	50 x 6 mm
f. Motors above 30 KW upto 90 KW, lighting panels, local panels	:	35 x 6 mm
e. Motors above 5 KW, 30 KW	:	25 x 3 mm
f. Motors upto 5 KW, Miscellaneous devices etc.	:	No. 8 S.W.G. G.I. wire

FOR TENDER PURPOSE ONLY

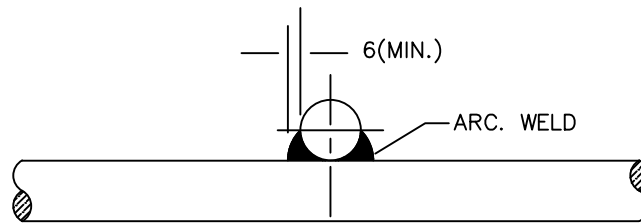
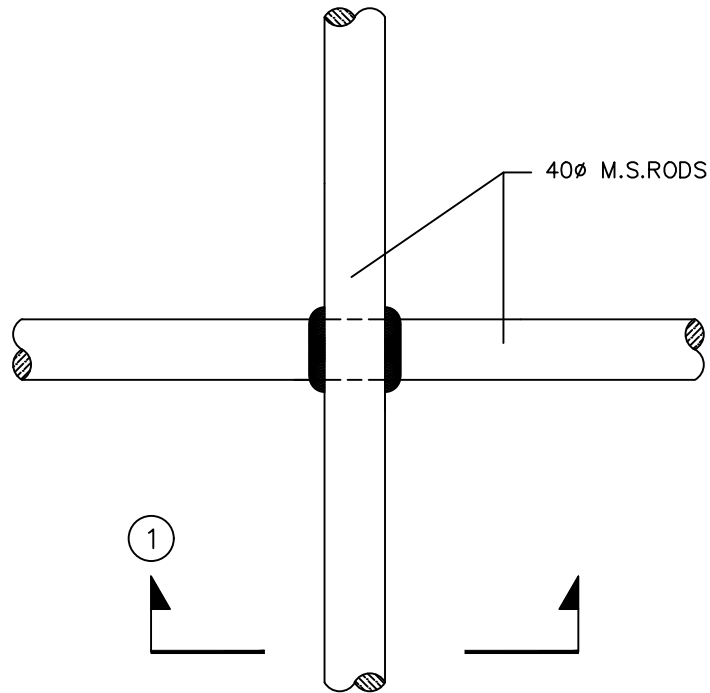
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DS	SM	BG	-	12.02.19			
APPVD.	REVWD.	CHKD.	REV.	DATE			



LAP JOINT
BETWEEN M.S. RODS

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0600	REV.
							SHT. 04 OF 26	-

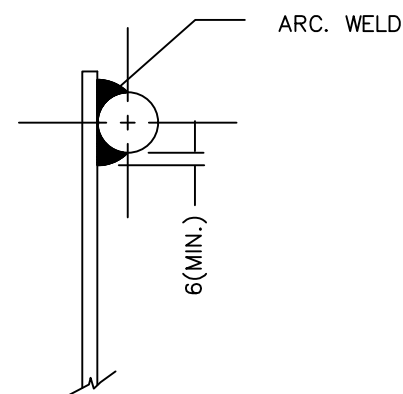
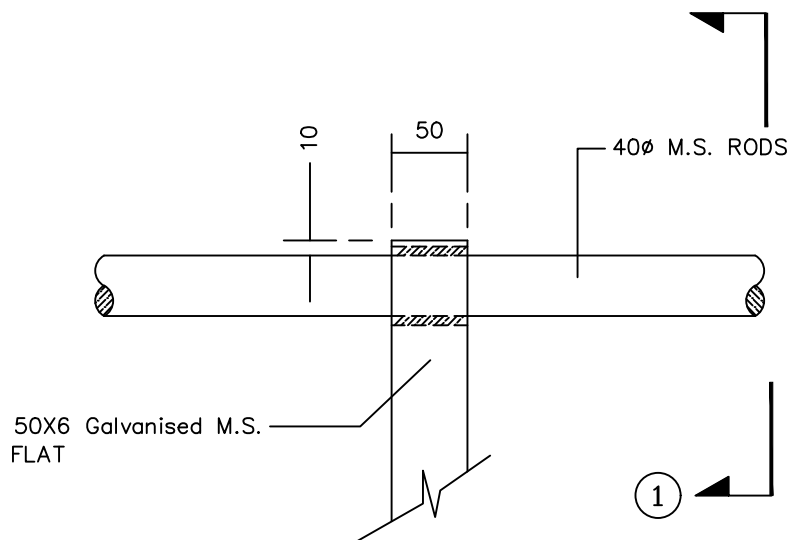


SECTION - ①

CROSS JOINT
BETWEEN M.S. RODS

FOR TENDER PURPOSE ONLY

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									CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19				JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 05 OF 26	REV. -	

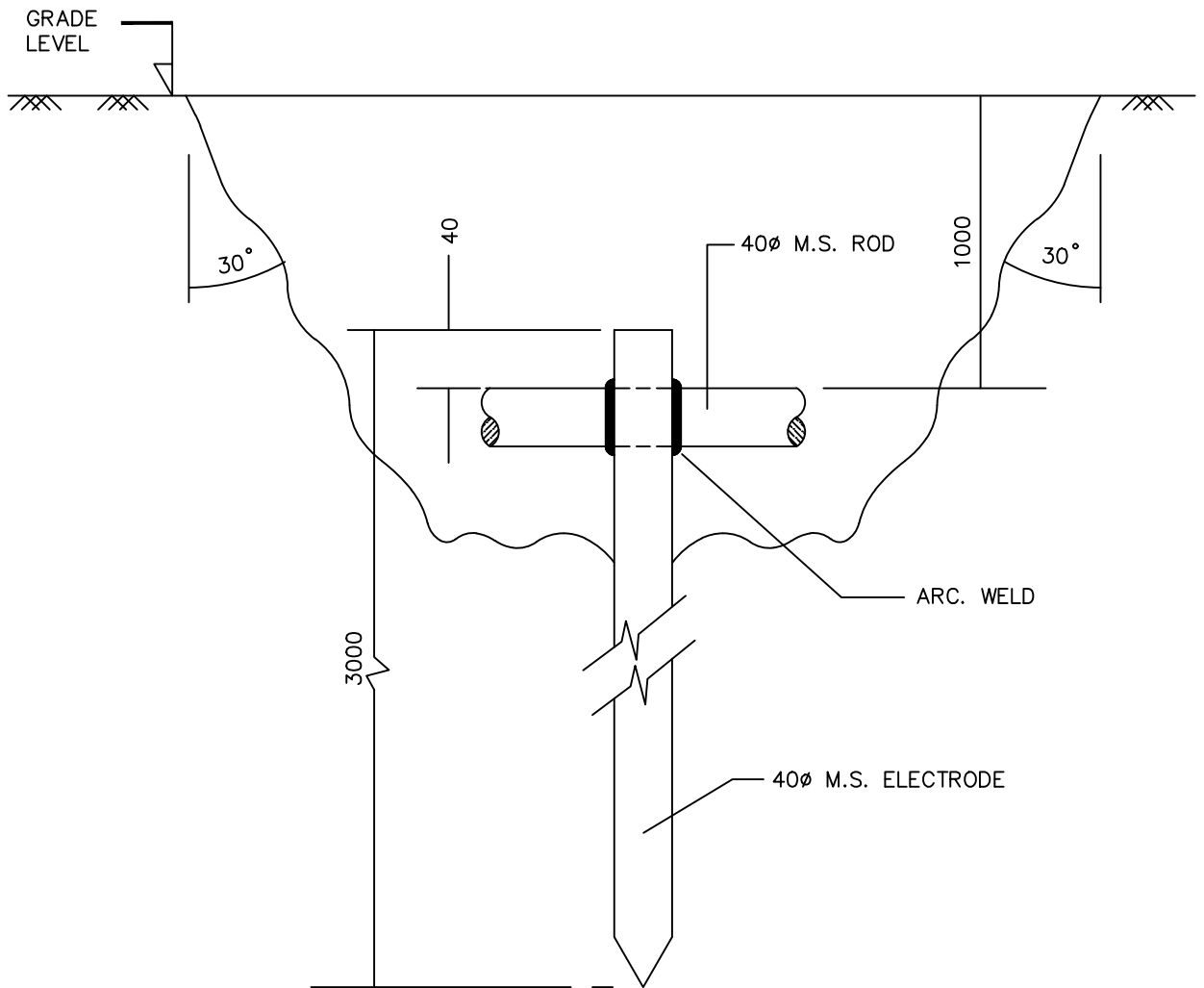


SECTION - ①

CROSS JOINT

FOR TENDER PURPOSE ONLY

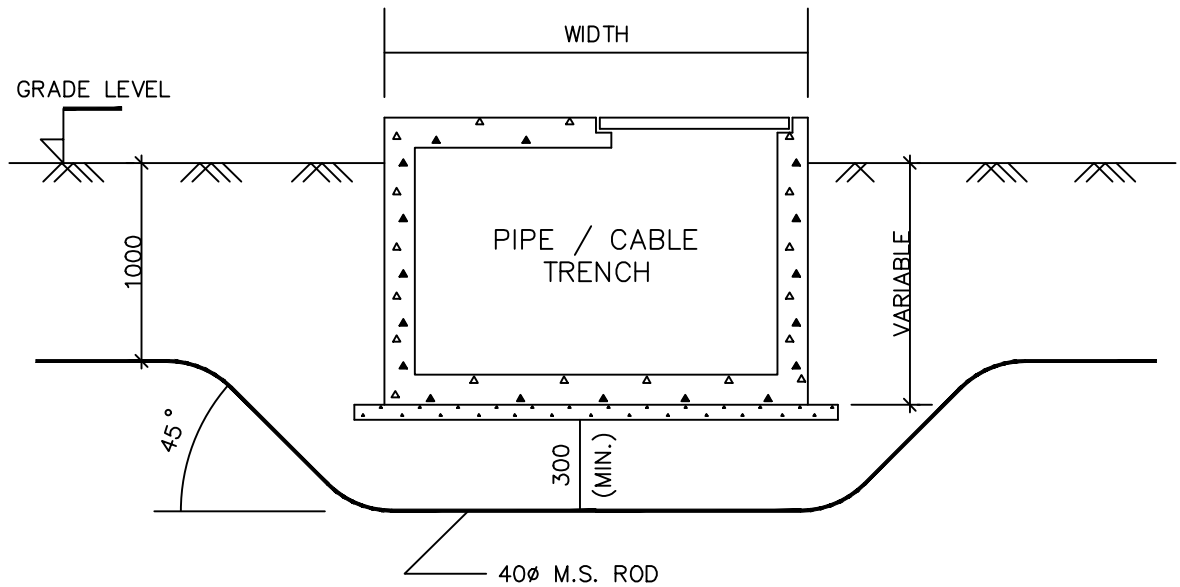
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APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0600 SHT. 06 OF 26	
							REV. -	



GROUND ELECTRODE

FOR TENDER PURPOSE ONLY

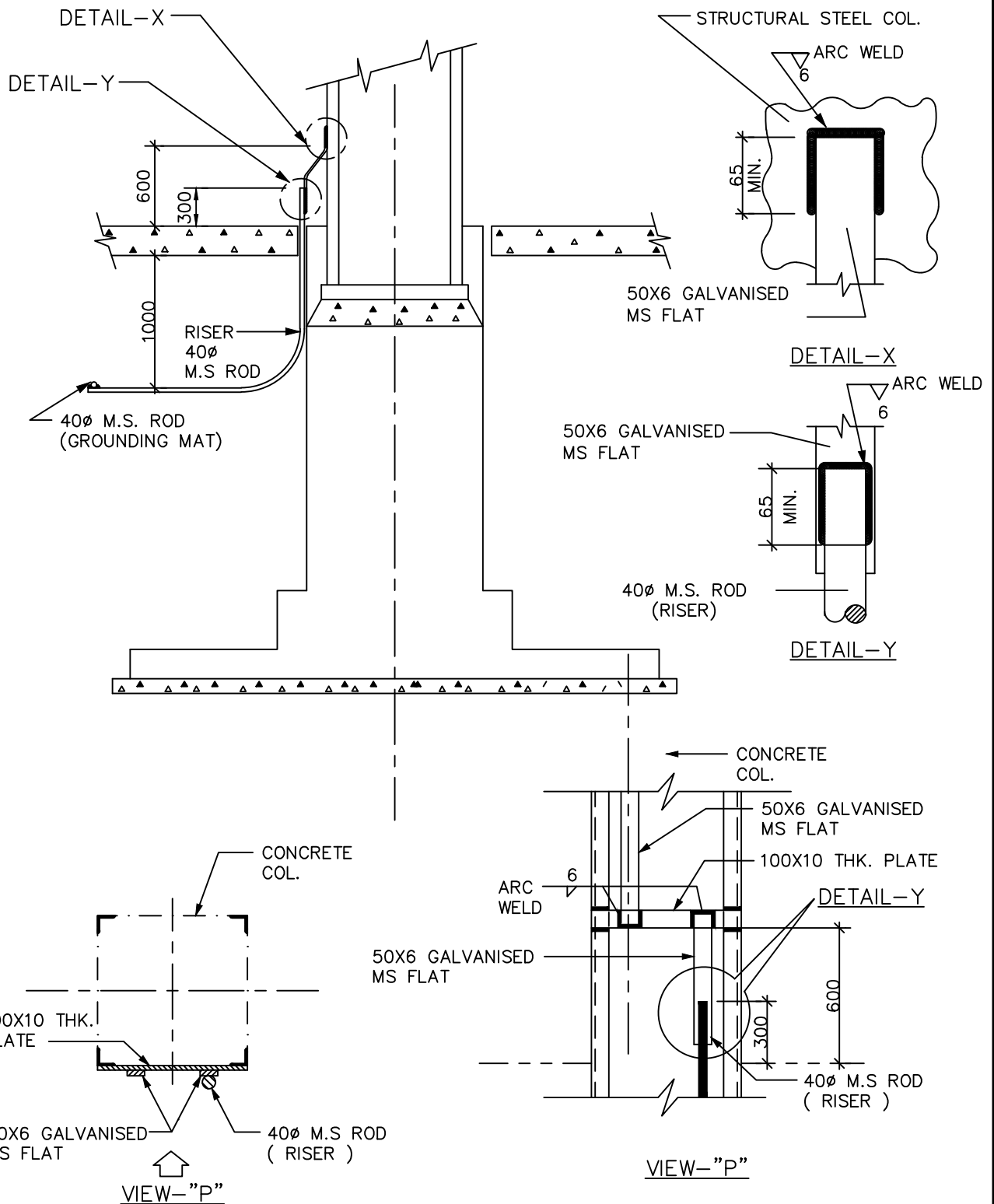
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APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0600 SHT. 07 OF 26	REV. -



TRENCH CROSSING OF GROUNDING CONDUCTOR

FOR TENDER PURPOSE ONLY

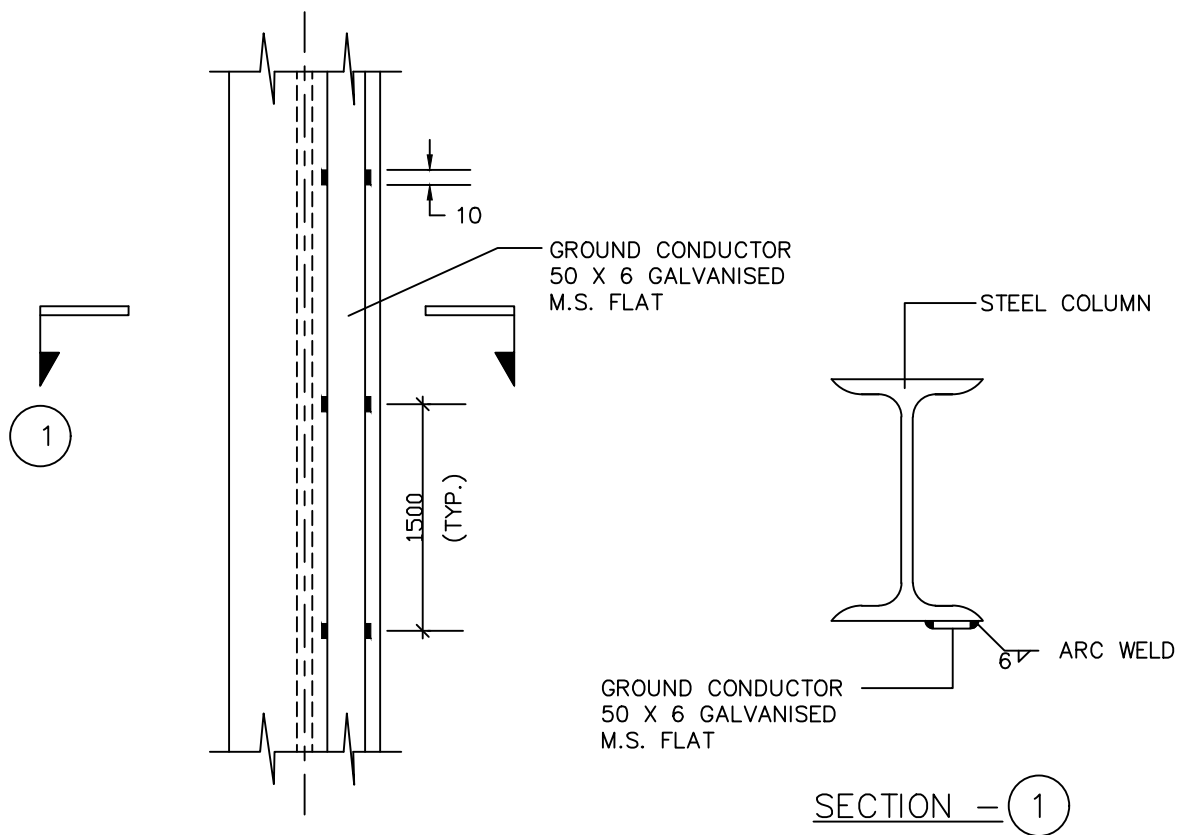
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APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0600 SHT. 08 OF 26	REV. -



GROUNDING OF STEEL & CONCRETE COL.

FOR TENDER PURPOSE ONLY

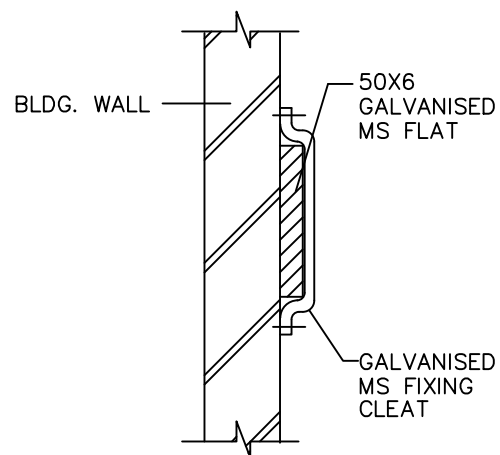
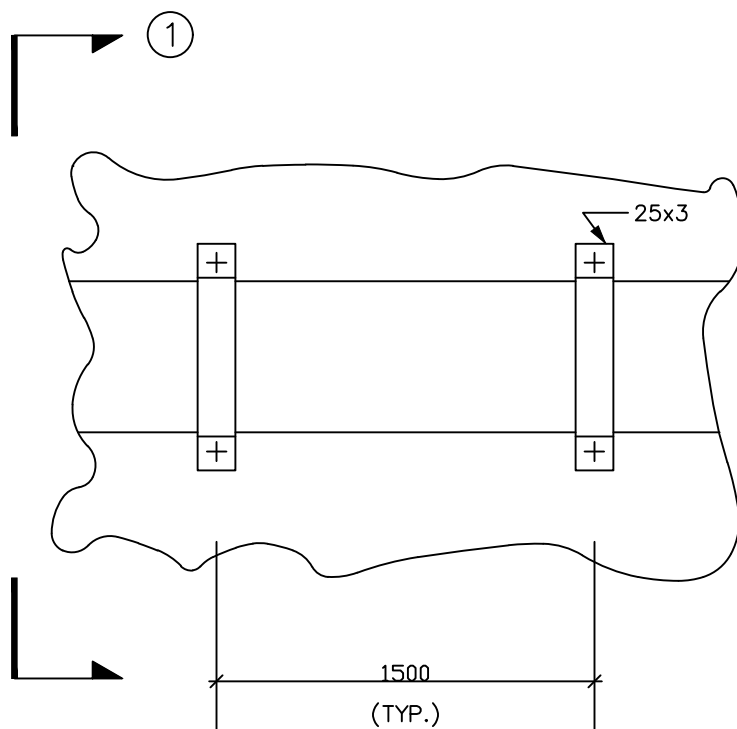
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2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0600	REV. -
DS	SM	BG	-	12.02.19	SHT. 09 OF 26	
APPVD.	REVWD.	CHKD.	REV.	DATE		



EARTHING CONDUCTOR
ALONG STEEL COLUMN

FOR TENDER PURPOSE ONLY

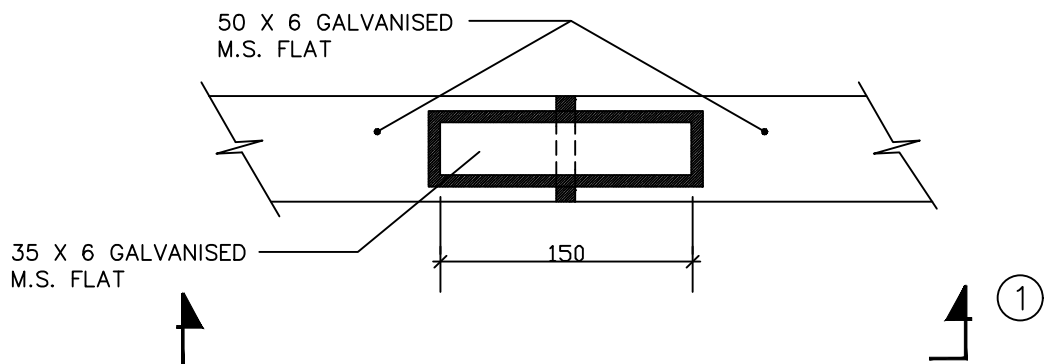
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APPVD.	REVWD.	CHKD.	REV.	DATE			



EARTHING CONDUCTOR
ALONG BUILDING WALL

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 11 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

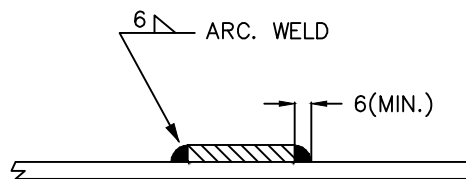
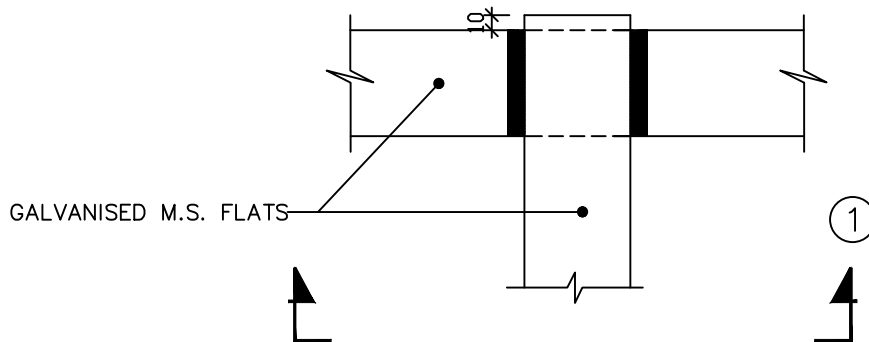


SECTION - ①

BUT JOINT BETWEEN GALVANISED M.S. FLATS

FOR TENDER PURPOSE ONLY

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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 12 OF 26	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		-	

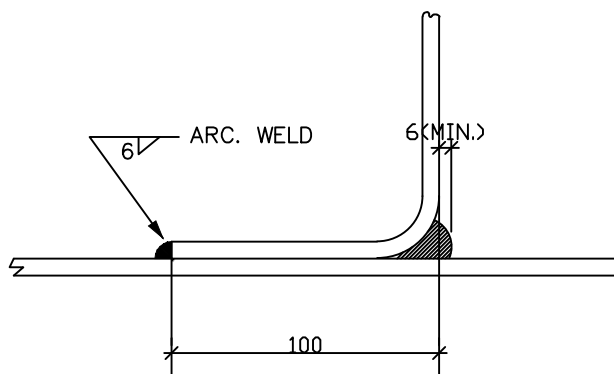
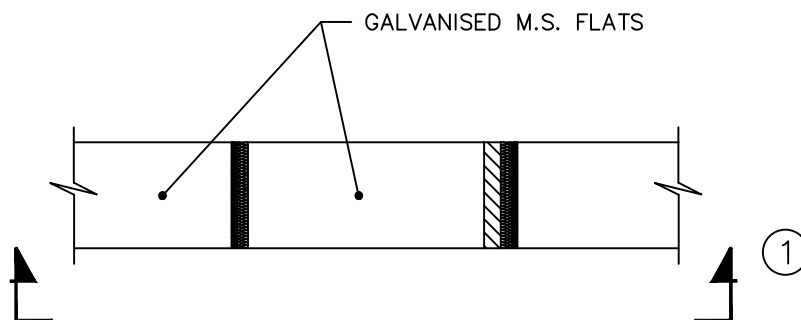


SECTION - ①

CROSS JOINT
BETWEEN GALVANISED M.S. FLATS

FOR TENDER PURPOSE ONLY

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APPVD.	REVWD.	CHKD.	REV.	DATE		

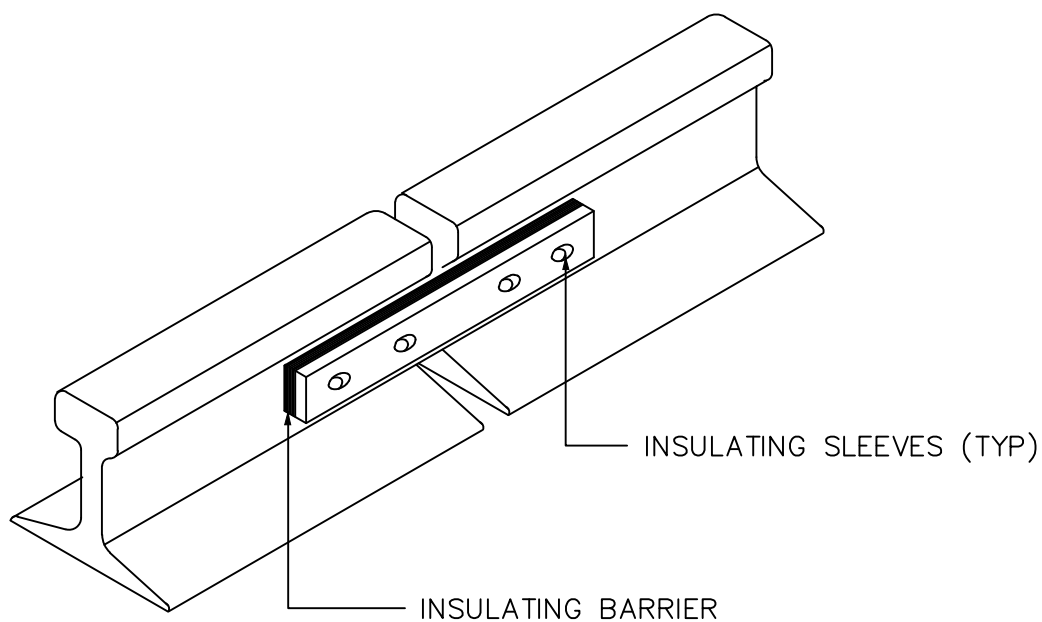


SECTION - ①

ANGULAR JOINT
BETWEEN GALVANISED M.S. FLATS

FOR TENDER PURPOSE ONLY

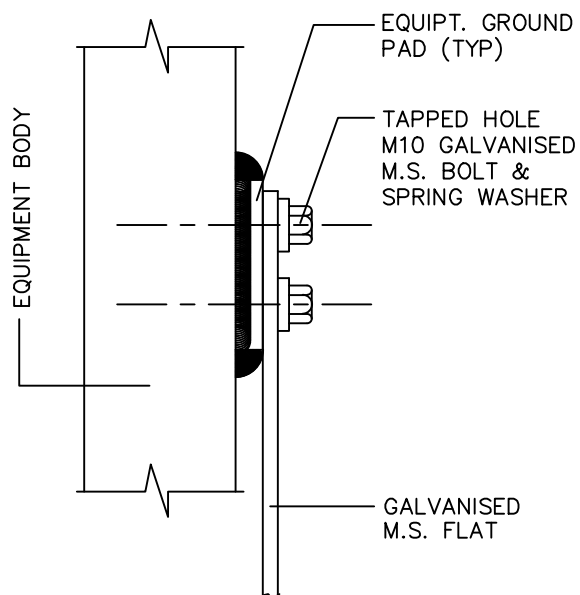
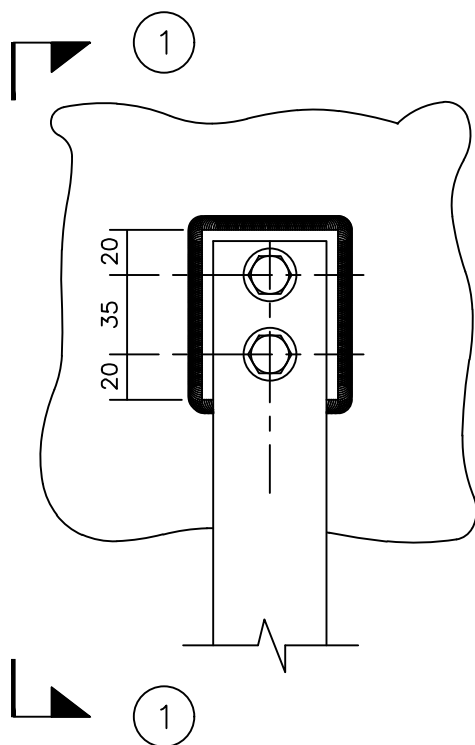
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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 14 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



RAIL SECTIONS LEAVING THE GROUND MAT

FOR TENDER PURPOSE ONLY

						GROUNDING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						 NLC TAMILNADU POWER LIMITED			
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09		SCALE : NTS
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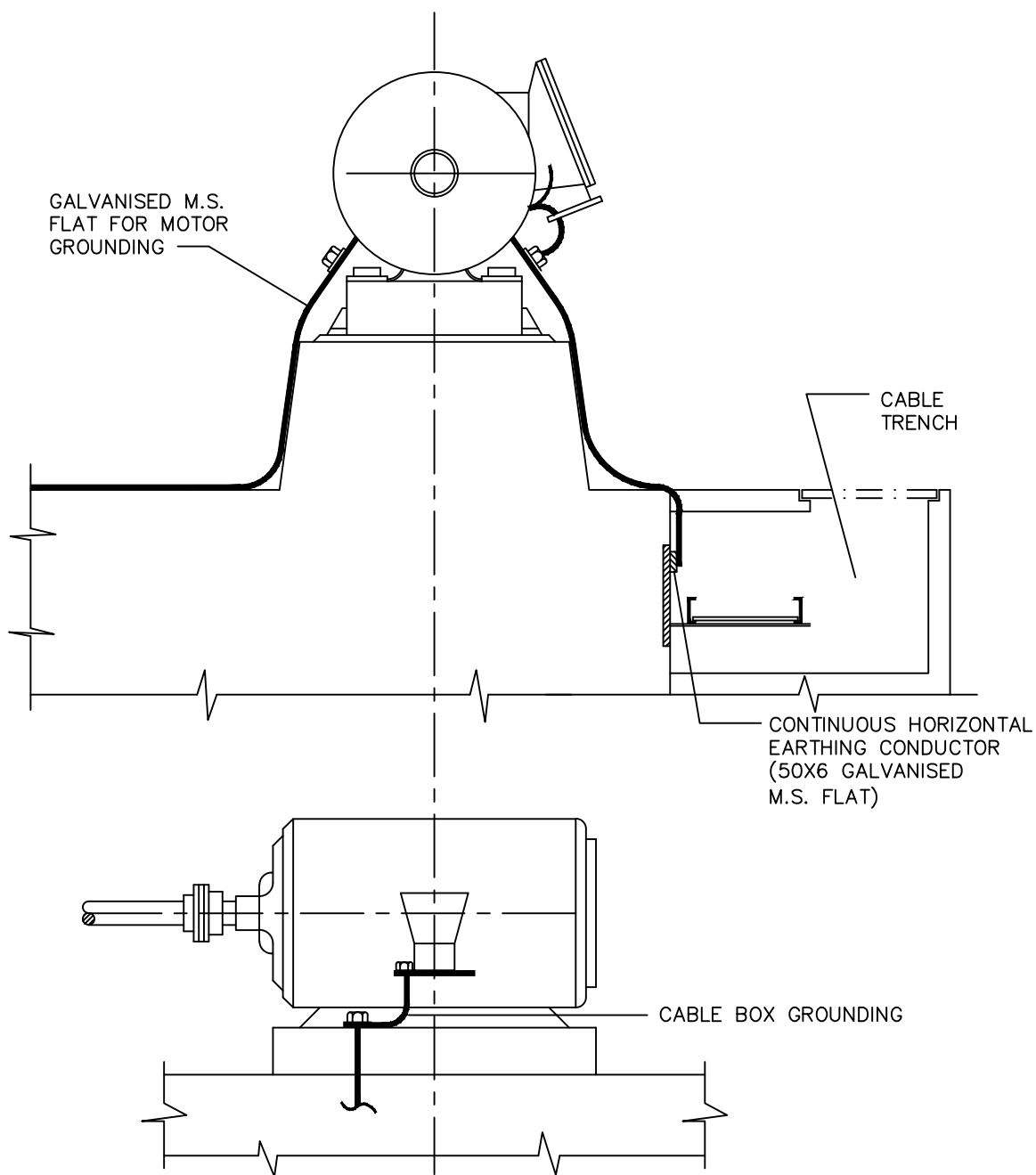


SECTION - ①-①

EQUIPMENT GROUNDING

FOR TENDER PURPOSE ONLY

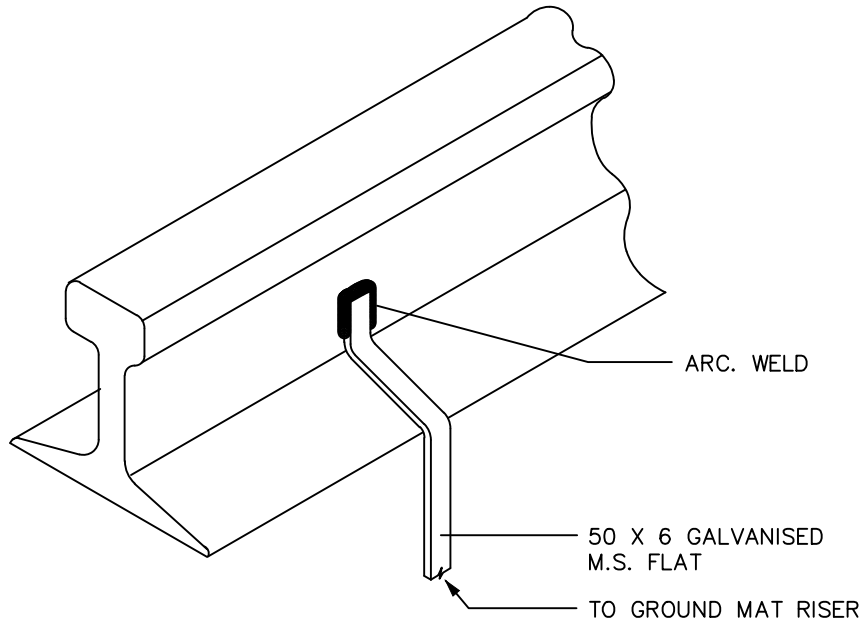
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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 16 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



MOTOR GROUNDING

FOR TENDER PURPOSE ONLY

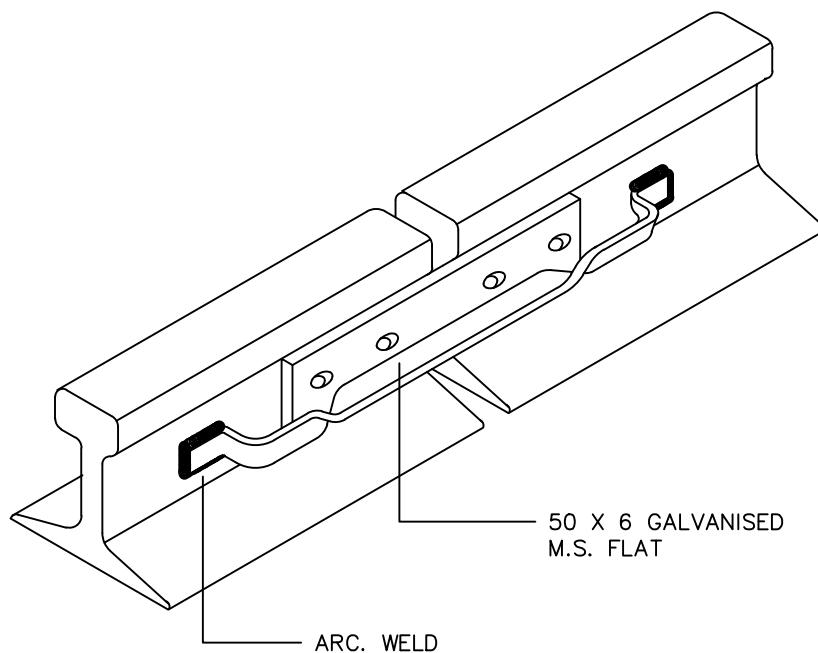
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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		SHT. 17 OF 26	-



RAIL GROUNDING

FOR TENDER PURPOSE ONLY

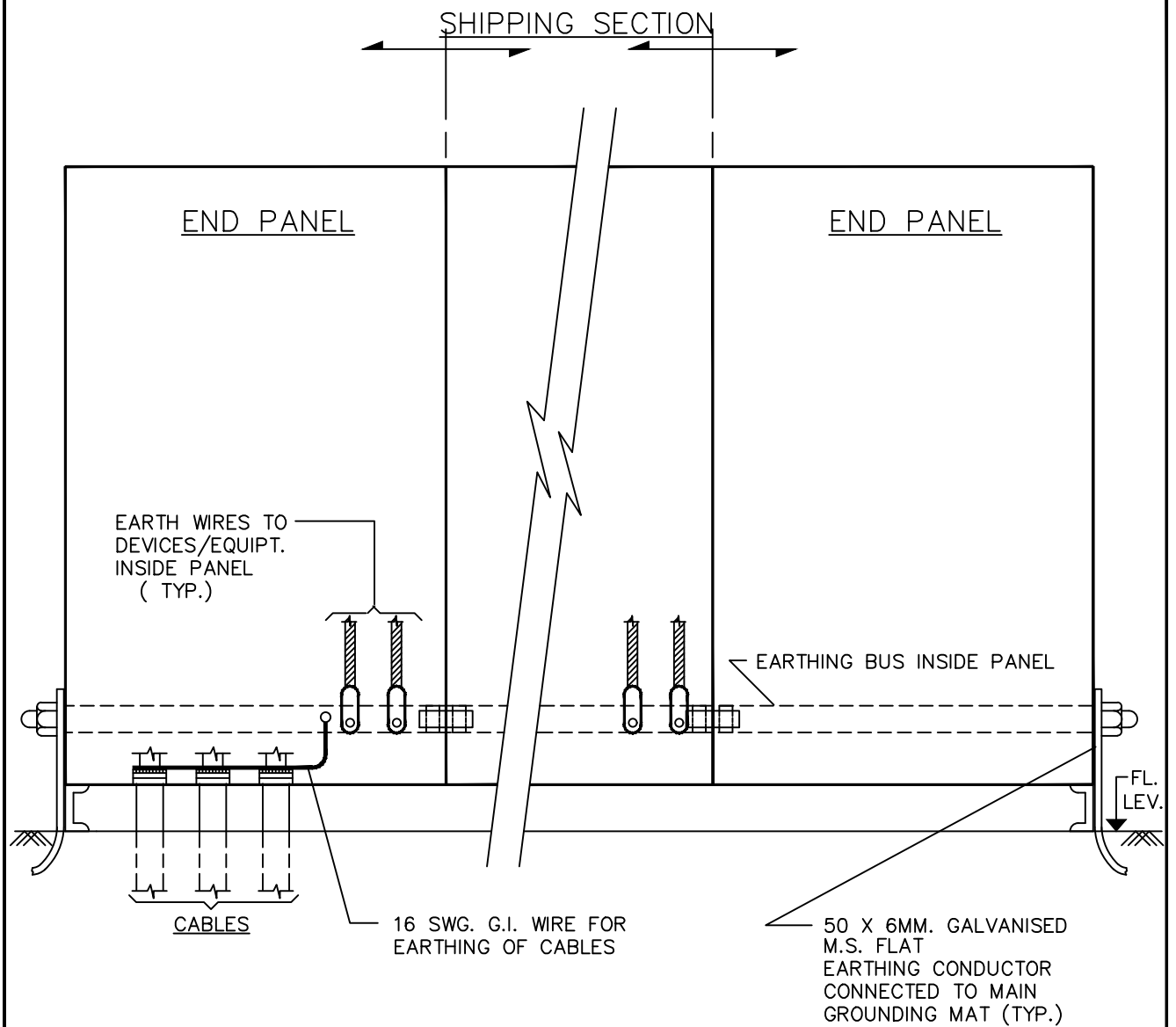
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DS	SM	BG	-	12.02.19			NLC TAMILNADU POWER LIMITED	JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 18 OF 26	REV. -	



RAIL BONDING

FOR TENDER PURPOSE ONLY

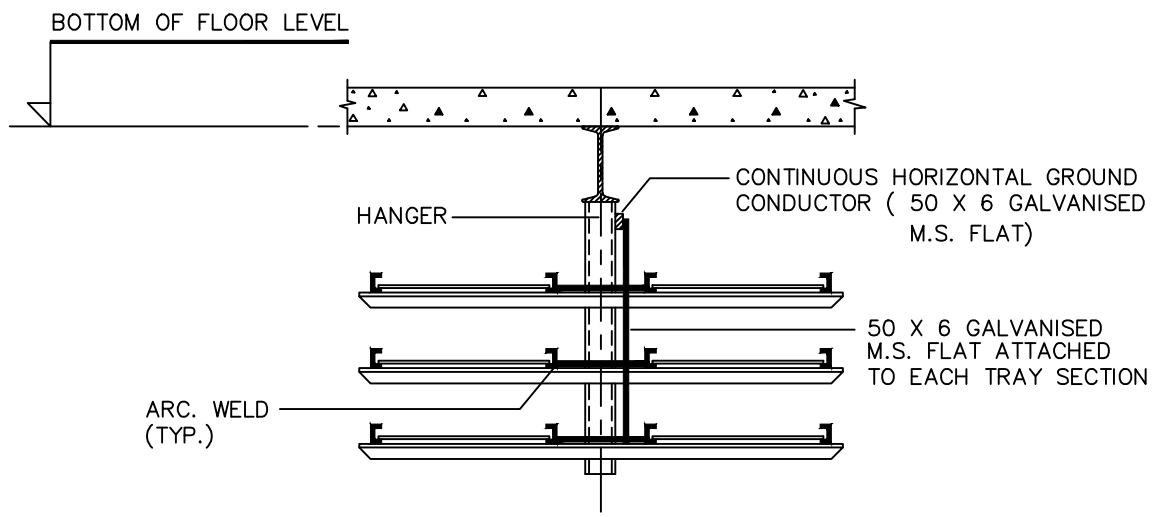
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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		SHT. 19 OF 26	-



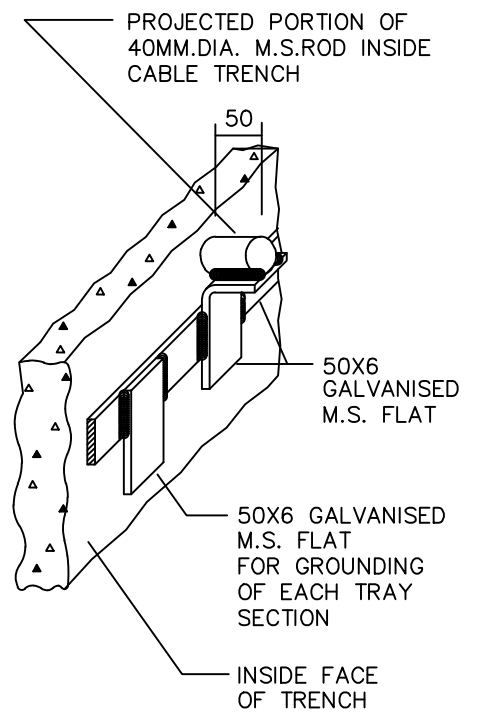
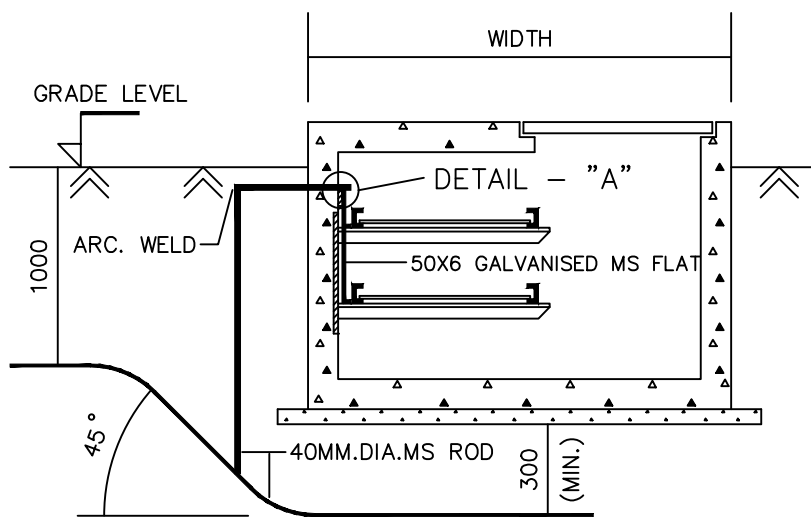
GROUNDING OF MCC, SWITCHGEAR

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0600 SHT. 20 OF 26	
							REV. -	



OVERHEAD CABLE TRAY GROUNDING

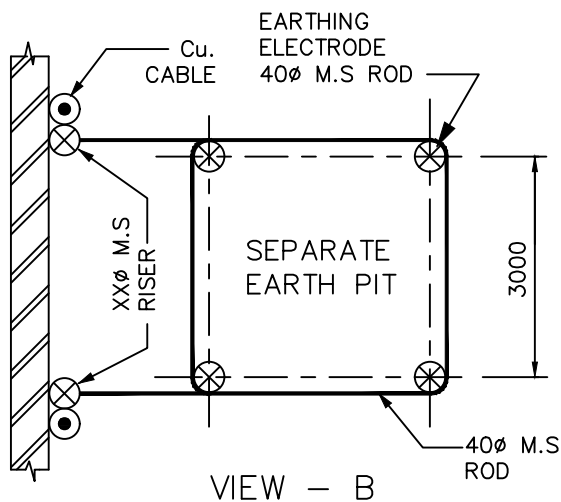
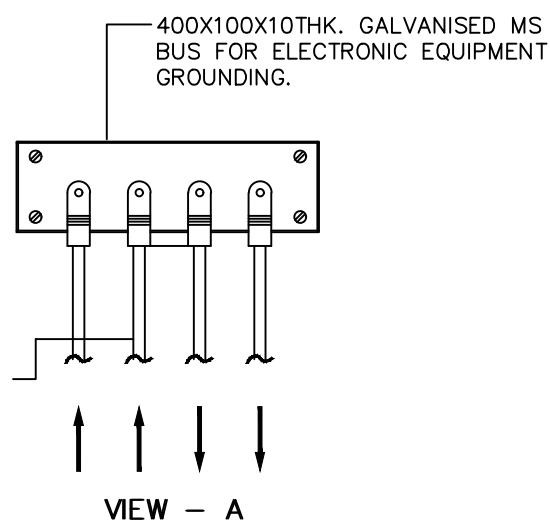
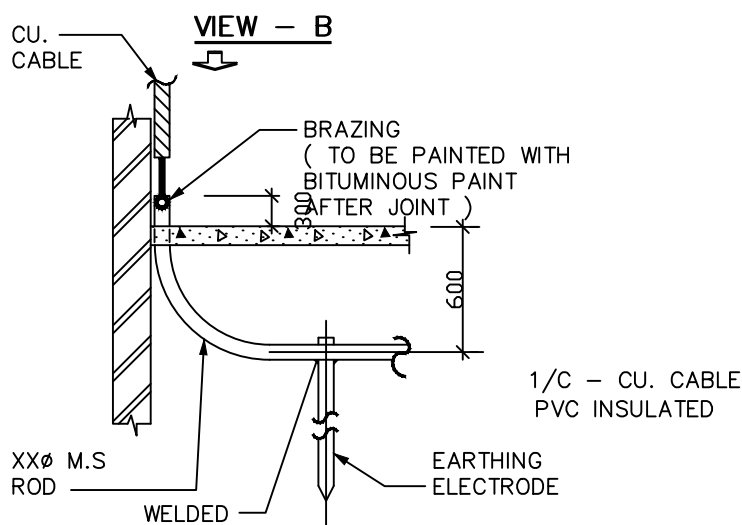
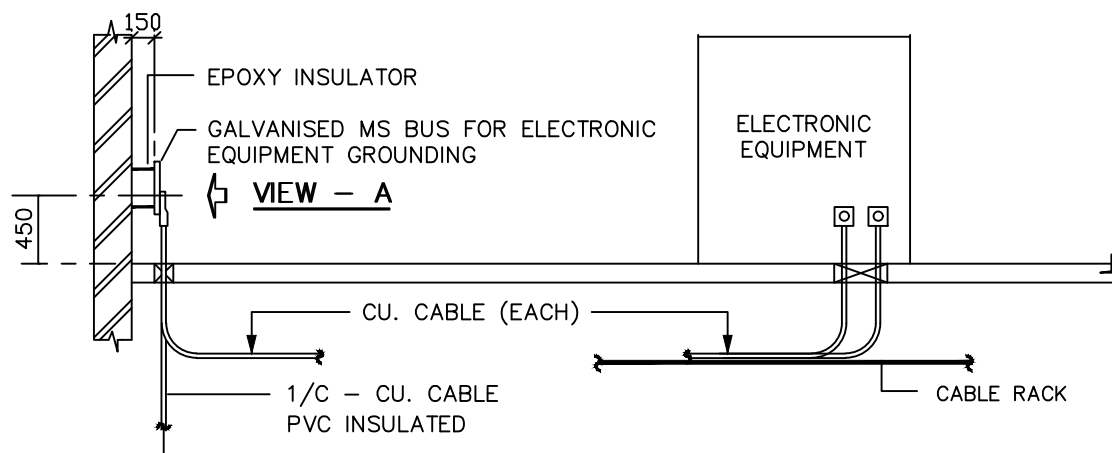


DETAIL - A

CABLE TRENCH GROUNDING

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS NLC TAMILNADU POWER LIMITED	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS JOB NO. 18A09 DWG. NO. 18A09-DWG-E-0600	SCALE : NTS	DWG. NO. 18A09-DWG-E-0600	REV. -
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	SHT. 21 OF 26			
APPVD.	REVWD.	CHKD.	REV.	DATE					



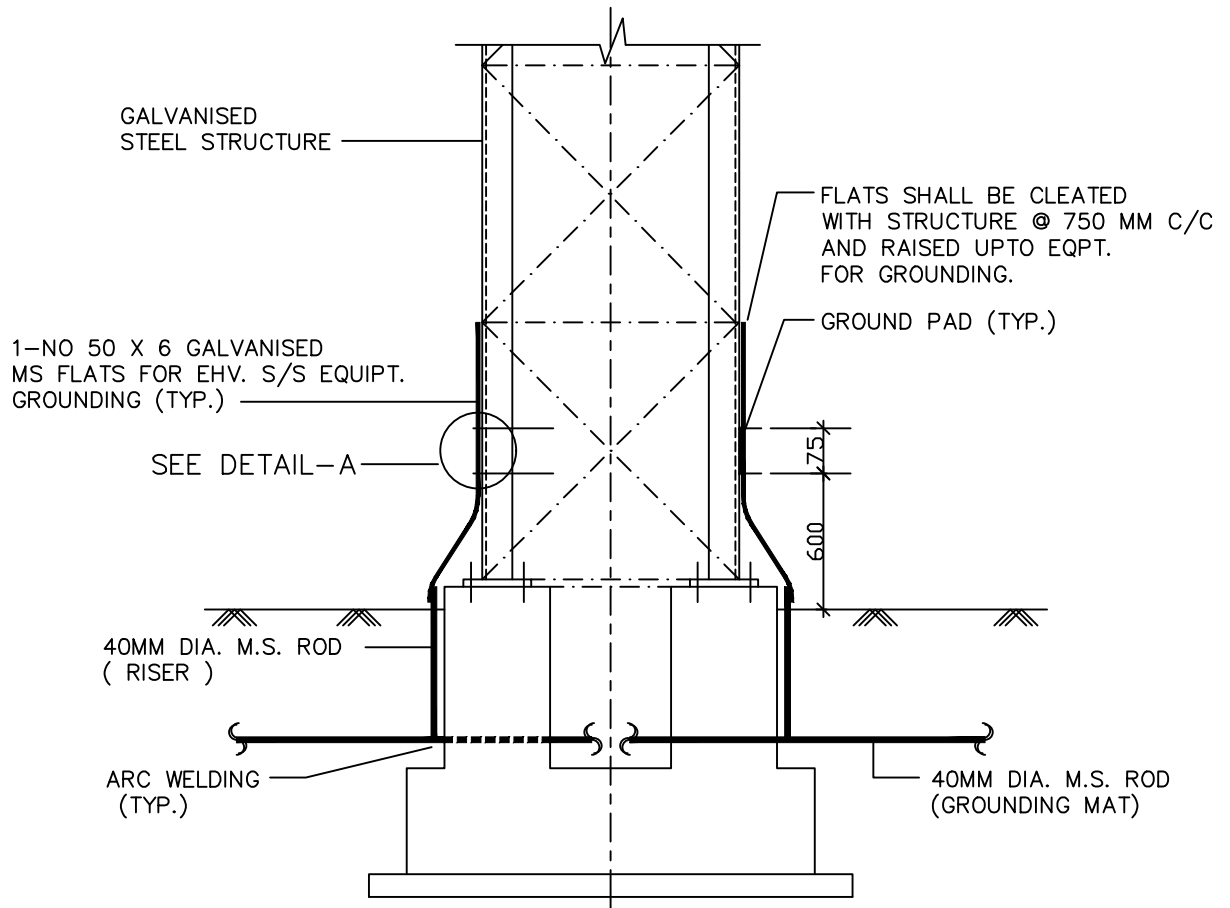
NOTES :

1. GALVANISED MS BUS SHALL BE MOUNTED ON INSULATOR BASE AT TWO SUITABLE LOCATIONS.
2. EACH ELECTRONIC EQUIPMENT/PANEL GROUND TERMINAL SHALL BE CONNECTED TO THE BUS BY MEANS OF CU. CABLE.
3. GROUND BUS SHALL IN TURN BE CONNECTED BY MEANS OF 2-1/C PVC INSULATED CU. CABLE TO SEPARATE EARTH PIT AT SUTABLE LOCATION.

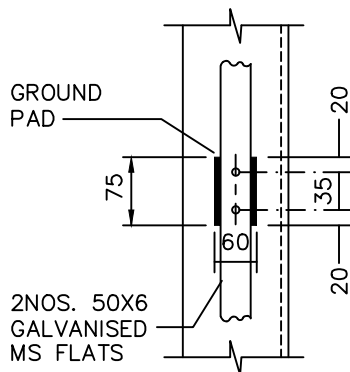
ELECTRONIC EQUIPMENT GROUNDING.

FOR TENDER PURPOSE ONLY

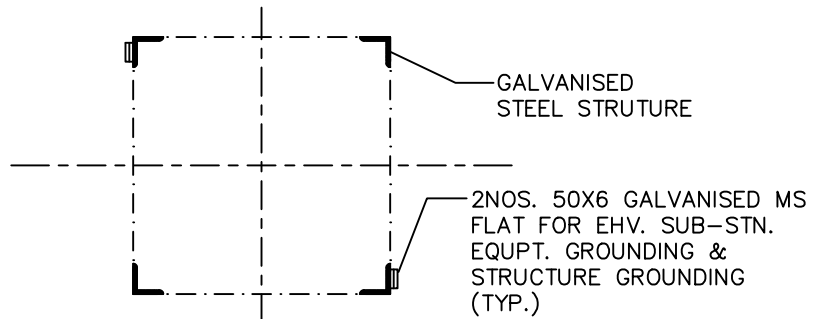
GROUNDING NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0600	REV. -
DS	SM	BG	-	12.02.19	SHT. 22 OF 26	
APPVD.	REVWD.	CHKD.	REV.	DATE		



SECTION



DETAIL - 'A'

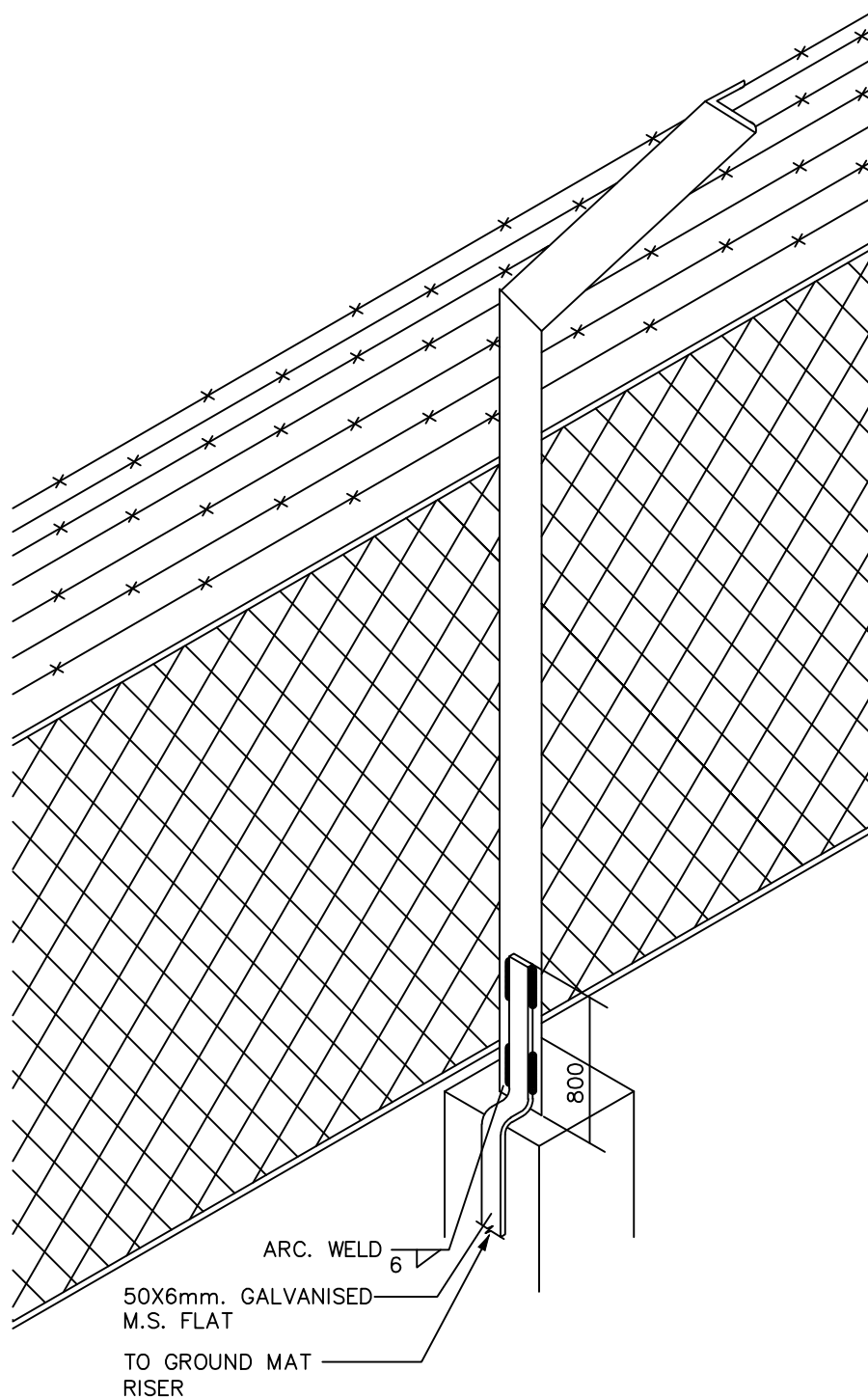


PLAN

GALVANISED STRUCTURE AND EQUIPMENT GROUNDING

FOR TENDER PURPOSE ONLY

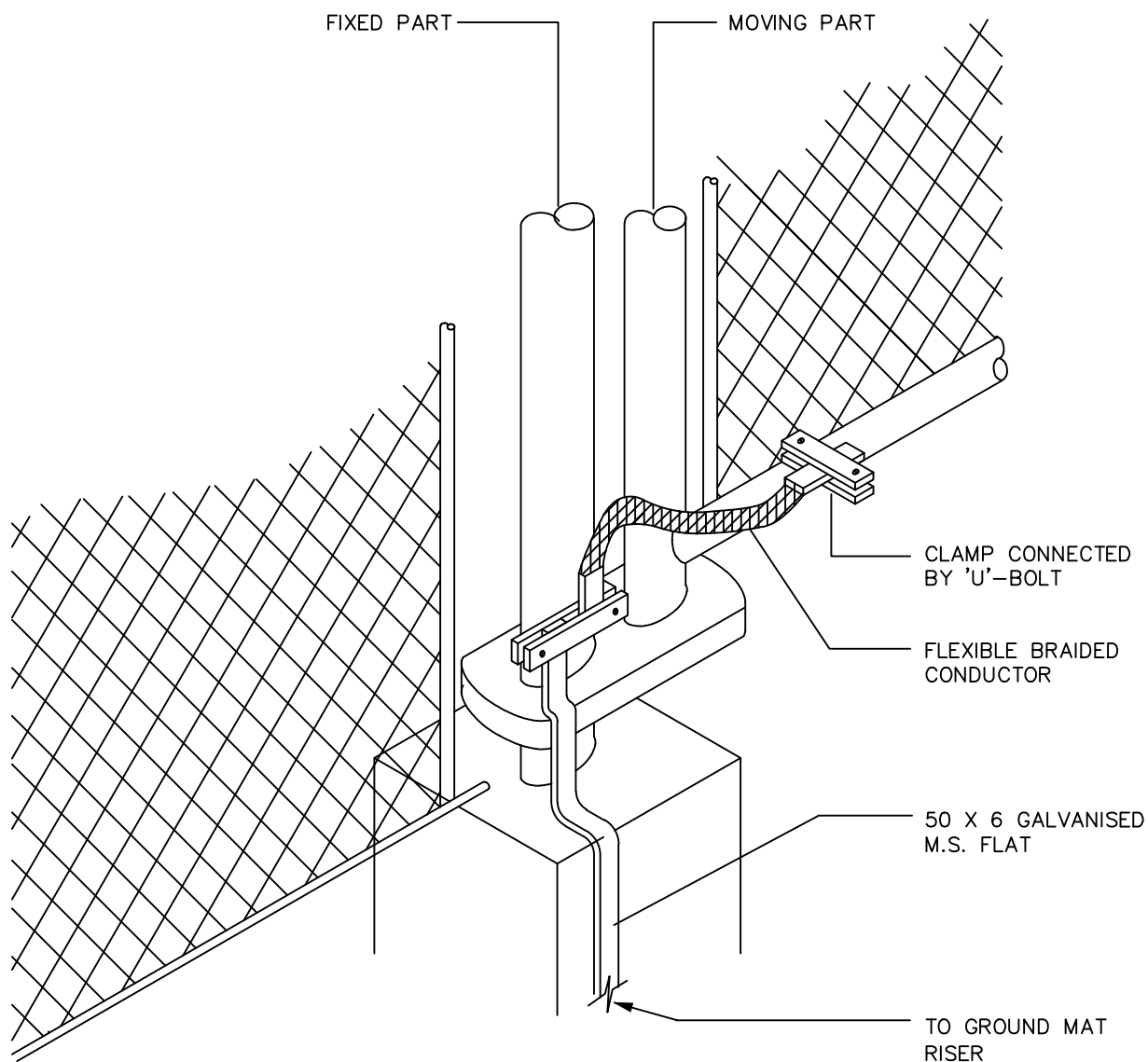
					GROUNDING NOTES & DETAILS  NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19		
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0600 SHT. 23 OF 26 REV. -



FENCE GROUNDING

FOR TENDER PURPOSE ONLY

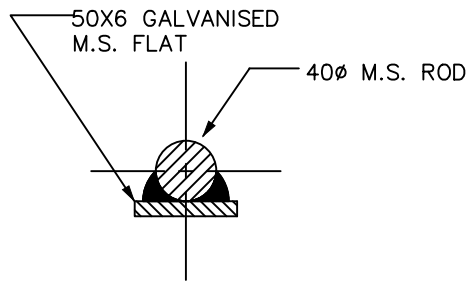
					GROUNDING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 24 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



FENCE GATE GROUNDING

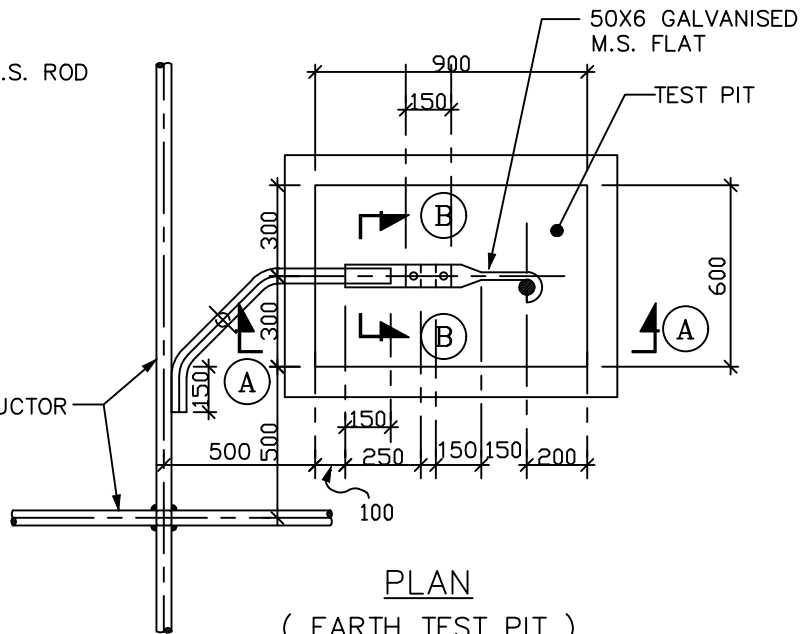
FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0600 SHT. 25 OF 26	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



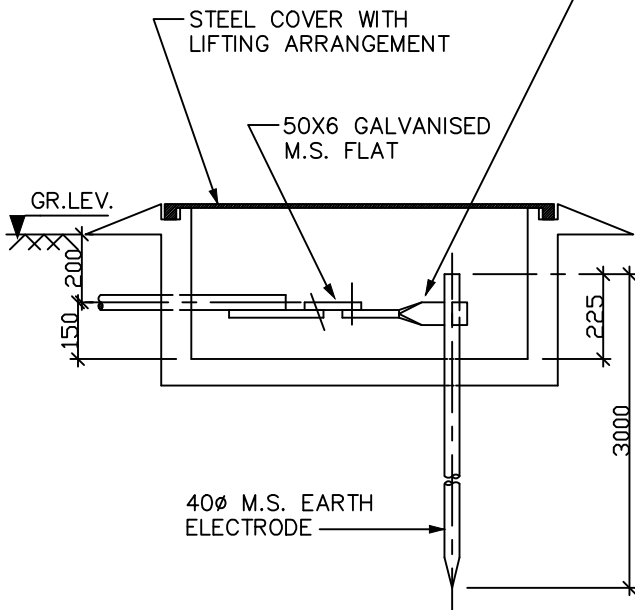
SECTION - BB

40mm M.S. EARTH CONDUCTOR

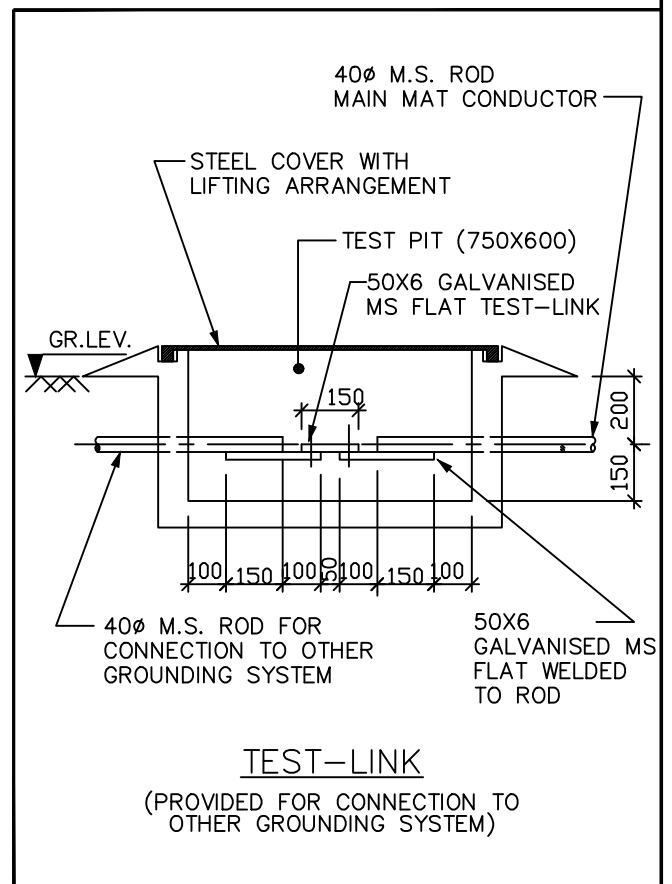


PLAN
(EARTH TEST PIT)

50X6 GALVANISED M.S. FLAT TWISTED AT 90° BY GAS HEATING AND WELDED TO ELECTRODE ON TOP AND BOTTOM ALL AROUND BEFORE ELECTRODE IS DRIVEN INTO THE EARTH



SECTION - AA



TEST-LINK
(PROVIDED FOR CONNECTION TO OTHER GROUNDING SYSTEM)

FOR TENDER PURPOSE ONLY

					GROUNDING NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0600 SHT. 26 OF 26	REV. -

ILLUMINATION
NOTES & DETAILS

DWG. NO. 18A09-DWG-E-0800

FOR TENDER PURPOSE ONLY

1. The notes define some areas of responsibility and construction practices to be used. The symbols are used to save notes and space in generating and interpreting the drawings. The details provide typical examples of lighting installations. The words lighting fixture and receptacles used in this document is synonymous to luminaire and sockets. The installation / support details shown are typical installation details. The Contractor is responsible for the structural adequacy of the installation.
2. These lighting notes and details shall be read and construed in conjunction with the Illumination Layout and drawings.
3. Except specifically approved by site office, installation of exposed conduits, mounting of lighting fixtures etc. shall be taken up only after all other services such as Piping, Air Ducting, Cable Tray/Busduct Hanger, Structural Bracings etc. in a particular area have been installed.
4. The Contractor shall develop final conduit/cable routing based on fixture location and other site conditions.
5. Unless otherwise shown, the mounting heights of lighting fixtures and accessories shall be generally as follows :
 - a) i) Low-Bay Lighting Fixtures : upto 3500 mm from bottom in general indoor Areas of Industrial plants.
 - ii) Medium Bay Type Fixtures. : above 3500 mm from bottom
 - b) Bracket lights over door : 300 mm bottom of Fixture Above top of opening
 - d) Receptacles -
 - i) In control room/office : 300 mm from finished floor
 - ii) Elsewhere : 1000 mm from finished floor
 - e) Local Switches : 1500 mm from finished floor
 - f) Lighting Panels : 1200 mm from finished floor
6. All lighting fixtures shall be fed from respective lighting panel. Normal AC lighting will be fed from normal lighting panel. Emergency AC lighting panel which in-turn connected with UPS.
7. Switchboard shall be used in office area. Separate switchboard has been considered for normal & emergency supply.

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0800 SHT. 01 OF 25	
							REV. -	

8. All lighting fixtures shall generally have LED type luminaires (colour temperature 4000k) unless otherwise noted. The type of fixture in different areas are as follows. Cable shall be normally laid in cable tray in main building. conduit wiring system shall be used for staircase, battery room etc.

Type	Philips LED option/Equivalent	Location
LA	Endural LED - Bulkhead luminaire WT 202W LED 6S CW PSU SI PC or Equivalent	Staircase
LT	Green Perform LED Batten BN 208C LED 40/DL LI 200 FR or Equivalent	Switchgear room, Electrical/Mechanical shop
LW	Waterproof IP65 Batten luminaire TCW 450 with 2x20W LED tube 1200mm 20W 840 T8 IND I or Equivalent	Battery room
LG	Energy efficient recess mounted LED luminaire suitable for 2x2 grid Cirrus RC 365B LED22 4000 PSU OD WH or Equivalent	Office, Electrical room with false ceiling
LM	Medium and high bay luminaire Green bay LED BY 400V LED 1355 CW SK PSU SI FGWH or Equivalent	TG hall, Operating floor
LD	Recess mounted LED down light for spot option Green LED DNI94B LED15S-4000 PSU WH or DNI92B LED9S-4000 PSU WH or equivalent	Control room

9. Receptacle circuits shall be kept separate and distinct from lighting circuits.
10. Lighting fixtures stems (pendants) shall be 19 mm galvanized rigid steel conduit. Recess mounted fixture shall be hanged through chain/ stem as per installation facility available for particular fixture.
11. Wires/cable shall be spliced only at junction boxes with ring-tongue lugs or approved equal.
12. For cable/wire numbering, PVC sleeve with cable/wire Tag number of different colour code shall be used.
13. All lighting fixtures, local switches and receptacle outlets shall be grounded in accordance with IS 3043, NBC & IE rule. Multicore Multicore (multi-conductor) cable shall be provided with integral ground wire. Where multicore cables are not used, each lighting/small power circuits shall carry a separate ground wire.
14. Unless otherwise noted, the minimum size of cables, conduits, junction boxes shall be as below :

A. CABLES

- i) From main lighting distribution : 1x3-1/2C, 95 Sq.mm
Boards to 415 V normal
AC lighting panels

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800 SHT. 02 OF 25	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

- ii) From lighting panel to junction box : 1x3C, 10 Sq.mm AL XLPE
- iii) From junction box to lighting fixtures : 1x3C, 2.5 Sq.mm Cu XLPE

B. CONDUITS

- i) Conduits for lighting fixtures and receptacles will not be shown on the lighting drawings. It is the responsibility of Contractor to detail the raceway system as required for the circuits shown on the lighting layouts and panel board/lighting schedules.
- ii) Exposed conduit shall be installed either perpendicular or parallel to adjacent structural steel in a workmanlike manner.
- iii) Galvanized flexible metallic conduit may be used for recessed lighting fixtures in suspended ceilings and in other dry areas subject to vibration.
- iv) Conduits shall be run at least 460mm (18") apart from flues, insulated steam pipes or hot water pipes. They shall be supported every 2450mm (8'-0"). All supporting material shall be zinc coated.
- v) Raceway system shall be complete and continuous in all respects prior to pulling any cable. All fittings, wireways and boxes shall be properly grounded and bonded.
- vi) Raceway for luminaries (lighting) and sockets (receptacles) shall be independent and separate from all other power and control raceways. No cable tray shall be used for routing of lighting or receptacle branch circuits.
- vii) All raceways shall be terminated with insulated bushings or conduit hubs.
- viii) All embedded conduit shall be HDPE or rigid galvanized steel conduit, unless otherwise noted. Conduits installed in concrete shall be a minimum of 27mm (1") in diameter.
- ix) Exposed lighting and receptacle conduit in clean, dry, areas, where the raceway will not be subjected to mechanical damage may be electrical metallic tubing (EMT). EMT fittings shall be compression type.
- x) All conduits shall be of galvanised steel of following minimum sizes :

CABLE SIZE	CONDUIT. SIZE					
	21MM	27MM	35MM	41MM	53MM	
a) 10 Sq.mm AL	-	2	5	7	8	Maximum No.of Conductors Admissible for conduit
b) 2.5 Sq.mm CU	3	5	9	-	-	

C. JUNCTION BOXES

CONDUIT SIZE (MM)	JUNCTION BOX SIZE (MM)			
	4-WAY	3-WAY	STRAIGHT THROUGH	90°
a) 21 / 27	150x150x100	150x100x100	88 Ø	88 Ø
b) 35 / 41	254x200x127	254x200x127	150x150x100	-
c) 53	254x200x127	254x200x127	254x200x127	-

FOR TENDER PURPOSE ONLY

						 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0800 SHT. 03 OF 25	REV.	-

All lighting panels/distribution boards, junction boxes, receptacles, Fixtures, Conduits, etc. shall be grounded in compliance with the provision of I.E. rule and as detailed below :

- a) Lighting Panels : 25 x 3 MM G.S. Flat
- b) Distribution Boards : 50 x 6 MM G.S. Flat
- c) Power Receptacles, Junction Boxes etc : Third core of the three core cable
- d) Lighting fixtures, switches, conduits etc. : Third core of the three core cable

D. RECEPTACLES

- i) Receptacles shall be 16A, 240VAC single phase duplex type with earth (ground) and fed from 240V lighting/receptacle distribution boards.
- ii) Sockets (receptacles) should be located in convenient locations and spaced to provide access to any point with a 25 meters (85'-0") extension cord.

E. LOCAL SWITCHES

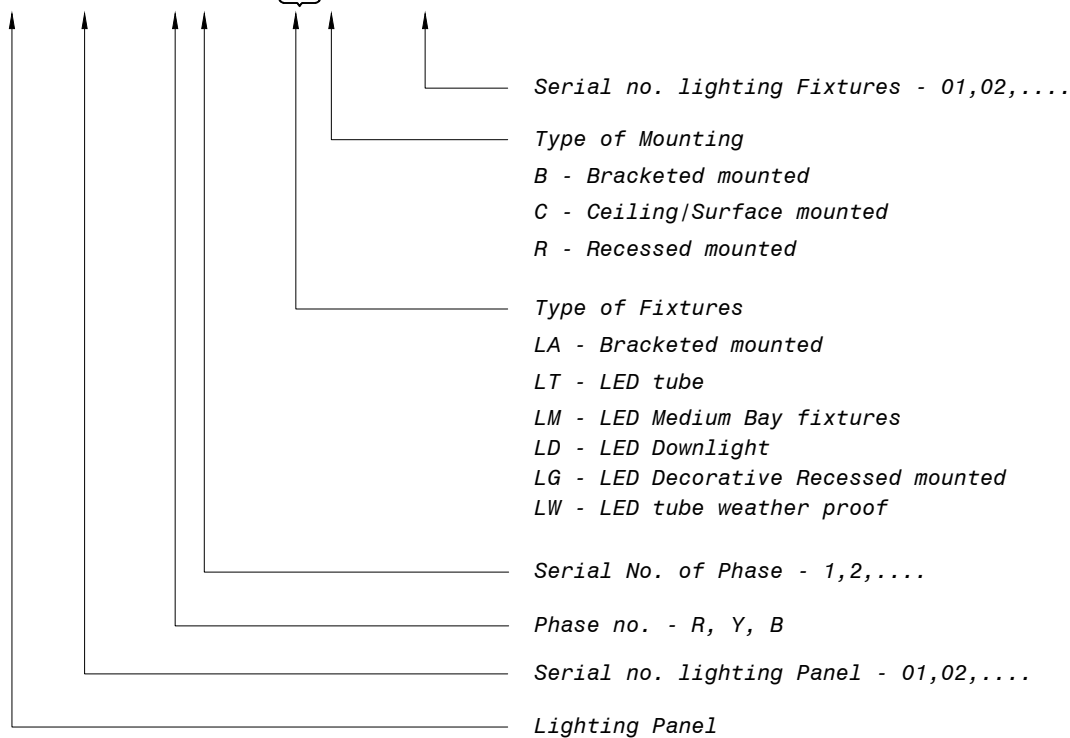
- i) Each local switch, light fixture, wall receptacle and other misc. devices in an office or room with hollow partitioned walls shall be flush mounted in a galvanized pressed steel outlet box of the knockout type of not less than 1.830 mm thick.
 - ii) Local switches, light fixture, wall receptacles and other misc. devices in all other indoor locations shall be surface mounted in cast hub box (FD Cast Device Box or equal) with sheet steel covers.
 - iii) Local switches, light fixtures, receptacles and other misc. devices in hazardous areas, corrosive areas or areas exposed to the weather shall be surface mounted in outlet boxes with covers approved for the particular conditions involved.
 - iv) Motion controlled light sensors shall be provided in hallways and conference rooms to enable switching off lights when not required.
 - v) Light switches shall be placed at the entry point of rooms. Where there are two entry points to a room, three way switches shall be employed. When there are three or more entry points to a room, four way switches shall be employed. If three or four way switches has current limitations for controlling the number of lighting fixtures, local switch with auxiliary relay and contactor shall be used for controlling the lighting fixtures.
 - vi) Switches controlling light fixtures and exhaust fans of battery room shall be located outside of the battery room.
15. The electrical installation work shall met the requirements of Indian Electricity Rules, relevant IS codes of practice and safety codes, all as ammended upto date. In addition, other rules or regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.
16. Typical details of lighting fixtures, other lighting system components and their mounting arrangement as shown herein are for general guidance only, The type no. of some make has been referred in the various drawings. Only to indicate desired appearance, construction features and performance of the fixture. The contractor has to design the same fulfilling the requirement of the specification.

FOR TENDER PURPOSE ONLY

					 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0800	REV.
						SHT. 04 OF 25	-

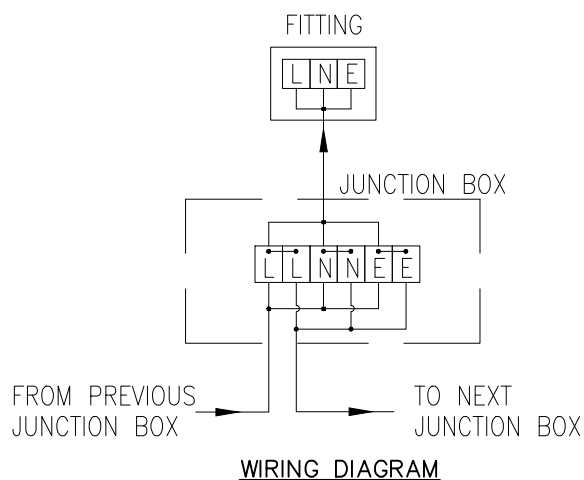
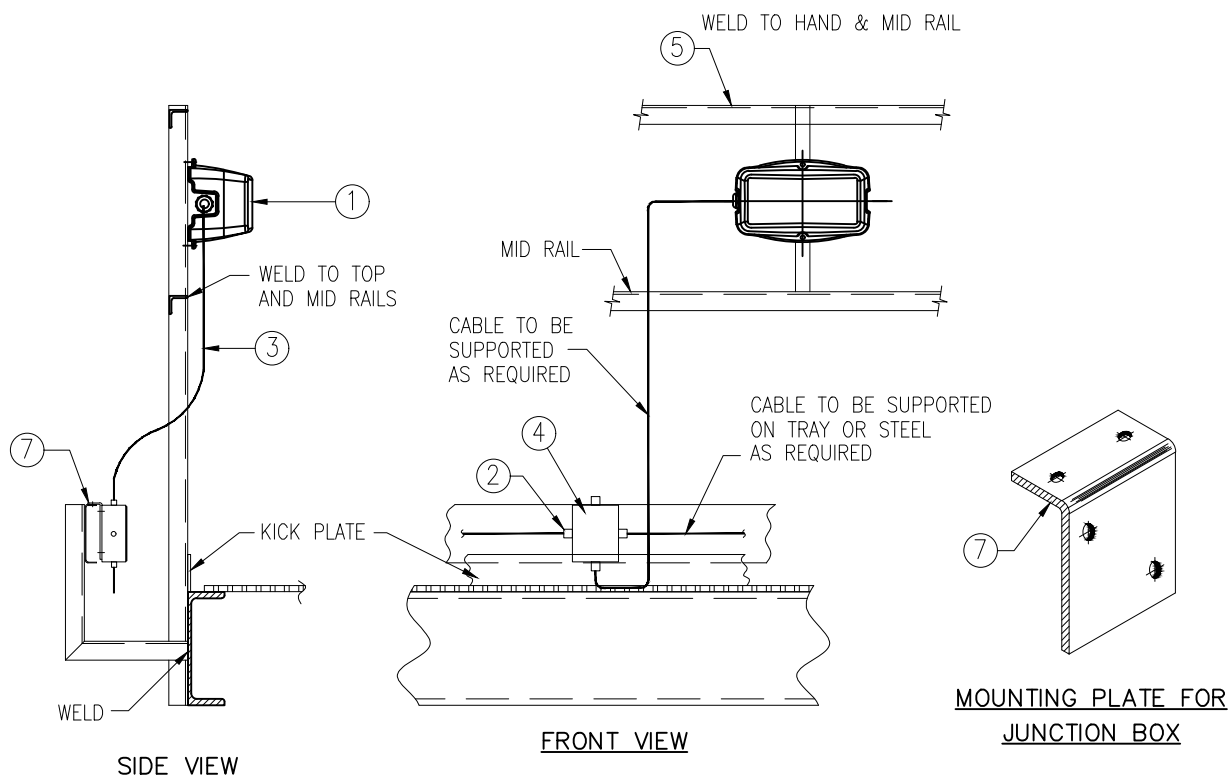
17. Lightnig fixtures numbering system is as follows :

XXX-XX - YY - UUV - MM



FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
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DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		SHT. 05 OF 25	-



**HANDRAIL MOUNTED
HORIZONTAL LED LUMINAIRE (TYPE-LA)**

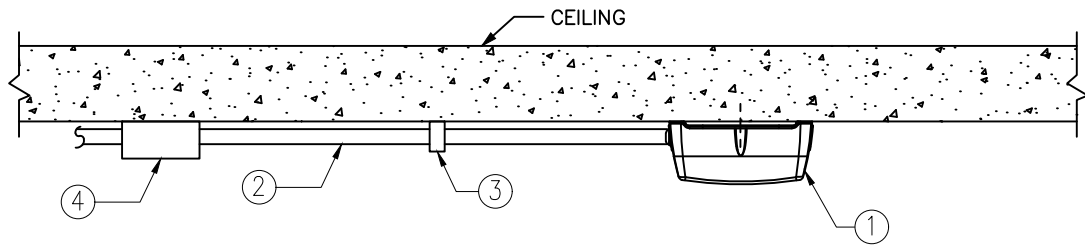
ITEM NO.	DESCRIPTION	QTY.
1	LED LUMINAIRE-WT202W LED65 CW PSU SI PC OR EQUIVALENT.	1 NO.
2	CABLE GLAND FOR ITEM 3	AS REQUIRED
3	3Cx2.5mm ² XLPE, SWA CABLE	AS REQUIRED
4	JUNCTION BOX	1 NO.
5	50x6mm MILD STEEL FLAT BAR	AS REQUIRED
6	M6x25mm Lg. MILD STEEL BOLT PLATED C/W NUT AND WASHER	AS REQUIRED
7	3mm THK. MILD STEEL PLATE	AS REQUIRED

NOTES:

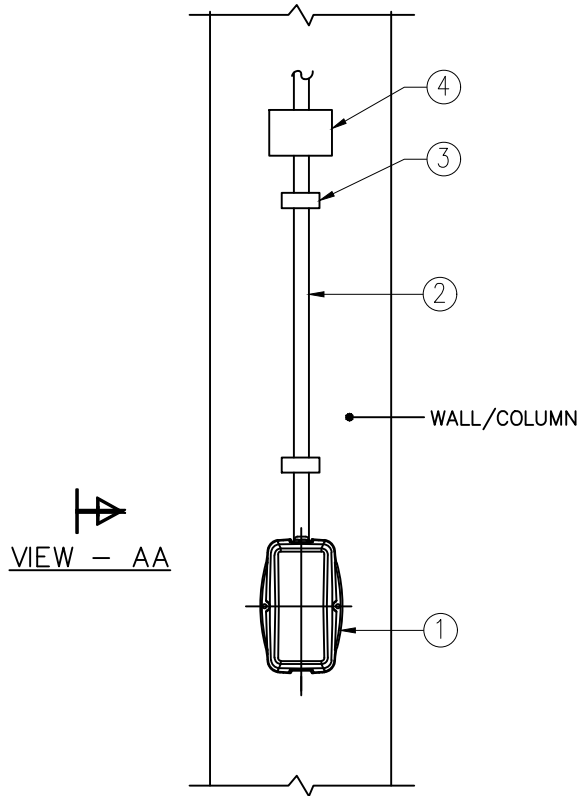
- ALL DIMENSIONS ARE IN MILLIMETERS (mm)
- ALL NUTS, BOLTS, WASHERS SHALL BE GALVANIZED OR ZINC PASSIVATED
- ALL SHARP EDGES AND BURRS SHALL BE REMOVED
- AFTER DRILLING, THE CHANNEL IS TO BE PREPARED, PRIMED AND PAINTED.

FOR TENDER PURPOSE ONLY

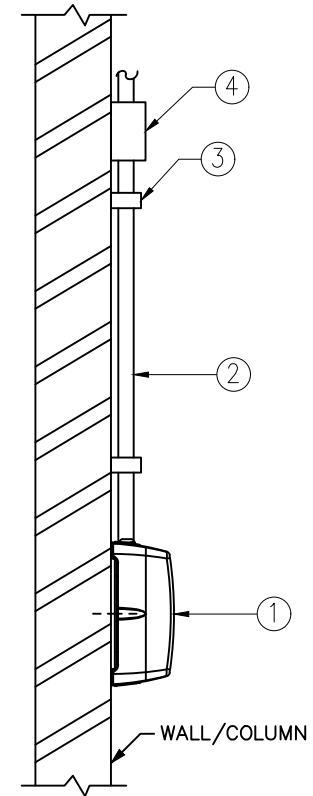
ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19	DWG. NO. 18A09-DWG-E-0800	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE	SHT. 06 OF 25	-
2X500MW THERMAL POWER PLANT AT TUTICORIN						



CEILING MOUNTING



WALL/COLUMN MOUNTING



VIEW - AA

BULKHEAD LUMINAIRE WALL/COLUMN/CEILING MOUNTED, TYPE-LA
(FOR STAIR CASE ONLY)

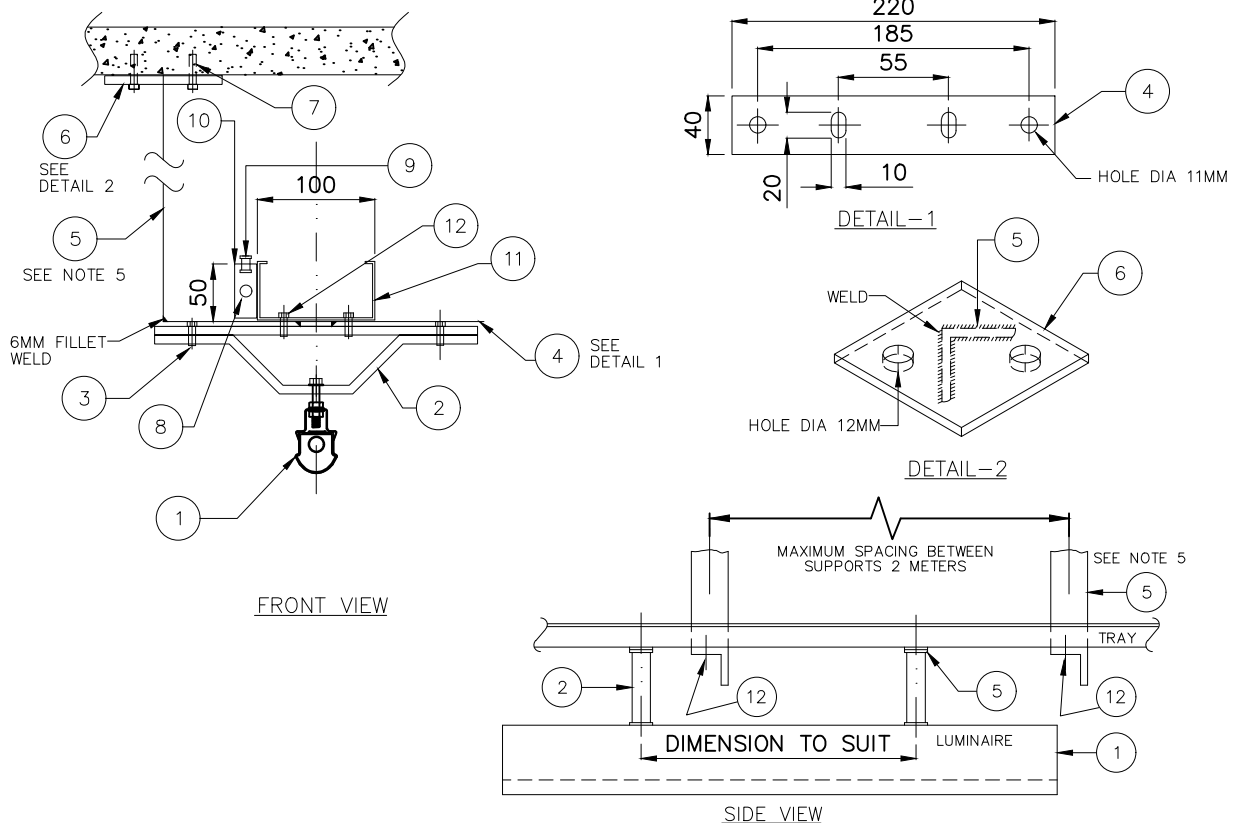
ITEM NO.	DESCRIPTION	QTY.
1	LED LUMINAIRE-WT202W LED65 CW PSU SI PC OR EQUIVALENT.	1 NO.
2	20 ϕ CONDUIT	AS REQUIRED
3	SADDLE	AS REQUIRED
4	JUNCTION BOX	1 NO.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm)
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANIZED OR ZINC PASSIVATED
3. ALL SHARP EDGES AND BURRS SHALL BE REMOVED
4. AFTER DRILLING, THE CHANNEL IS TO BE PREPARED, PRIMED AND PAINTED.

FOR TENDER PURPOSE ONLY

					 NLC TAMILNADU POWER LIMITED	  DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	  DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0800	REV.
							SHT. 07 OF 25	-



ELECTRICAL INSTALLATION OF STANDARD FLOURESCENT LUMINAIRE MOUNTED ON TRAY, 2x40W, GREEN PERFORM BATTEN LED OR EQUIVALENT IP31, TYPE LT

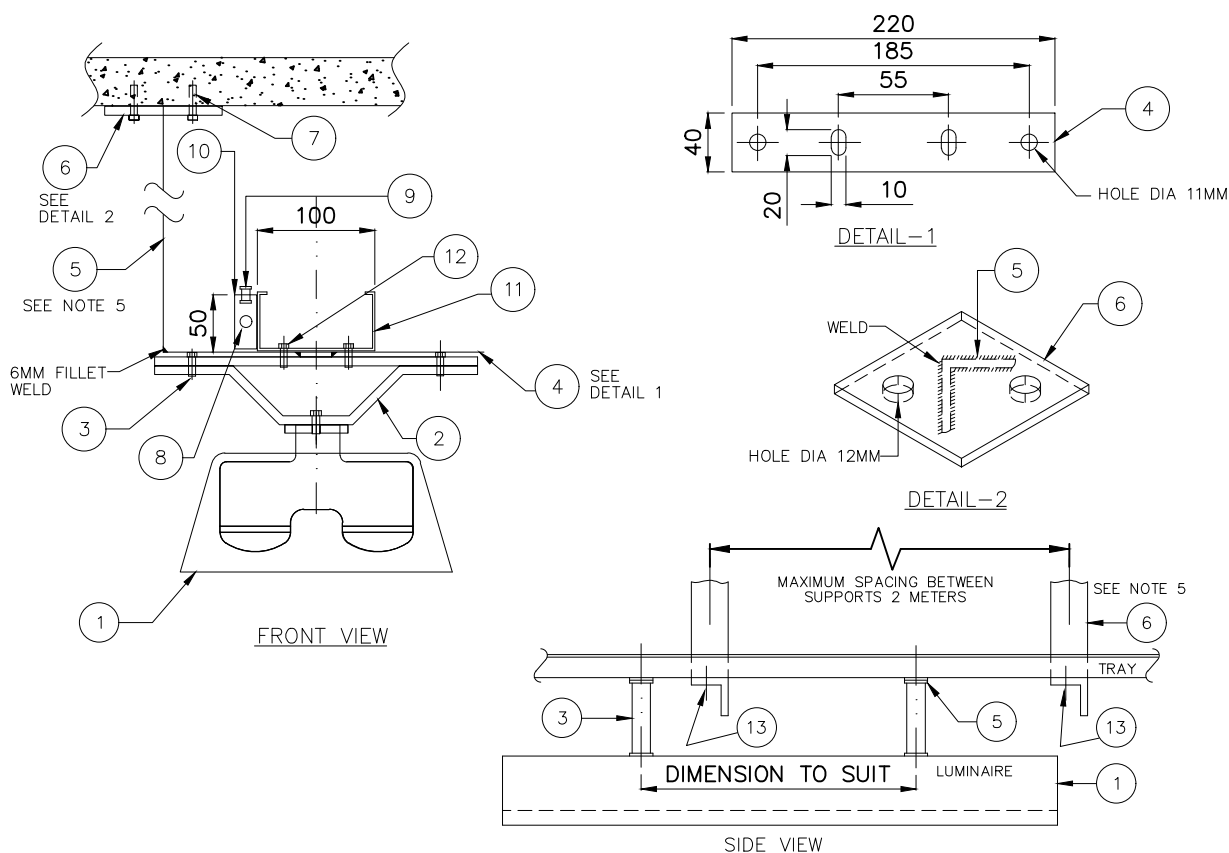
ITEM No.	DESCRIPTION	QUANTITY
1	FLUORESCENT LUMINAIRE - 2x40W, BN 208C LED 40/DL LI 200 FR OR EQUIVALENT	1 EACH
2	CEILING BRACKET	2 EACH
3	M10x20mm LONG NUT, BOLT AND WASHER	5 EACH
4	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	2 EACH
5	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
6	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
7	S10M RED HEAD ANCHOR AND BOLTS	2 EACH
8	CABLE - 1.1kV 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
9	GLAND - INDUSTRIAL, IP55 (FOR ITEM 9)	2 EACH
10	JUNCTION BOX - INDUSTRIAL IP55	1 EACH
11	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
12	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	AS REQUIRED

NOTES :-

- ALL DIMENSIONS ARE IN MILLIMETERS (mm).
- ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
- ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
- ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.
- THE LENGTH OF SUPPORT SHALL BE ADJUSTED TO MAINTAIN THE REQUIRED ELEVATION MARKED IN LIGHTING LAYOUT.
- THE LOCATION AND SIZE OF JUNCTION BOX IS INDICATIVE ONLY. FIELD ENGINEER MAY LOCATE AS PER SITE CONDITION.

FOR TENDER PURPOSE ONLY

ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0800	REV. -
DS	SM	BG	-	12.02.19	SHT. 08 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE		



ELECTRICAL INSTALLATION OF LED TUBE (WEATHER PROOF) LUMINAIRE MOUNTED ON TRAY, 2x20W, TCW 450 LED OR EQUIVALENT IP65, TYPE LW

ITEM No.	DESCRIPTION	QUANTITY
1	FLUORESCENT LUMINAIRE – 2x20W LED TUBE 20W 840 T8 INDI OR EQUIVALENT IN TCW 450 OR EQUIVALENT	1 EACH
2	CEILING BRACKET	2 EACH
3	M10x20mm LONG NUT, BOLT AND WASHER	5 EACH
4	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	2 EACH
5	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
6	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
7	S10M RED HEAD ANCHOR AND BOLTS	2 EACH
8	CABLE – 1.1kV 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
9	GLAND – INDUSTRIAL, IP55 (FOR ITEM 9)	2 EACH
10	JUNCTION BOX – INDUSTRIAL IP55	1 EACH
11	CABLE TRAY – 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
12	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	AS REQUIRED

NOTES :-

- ALL DIMENSIONS ARE IN MILLIMETERS (mm).
- ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
- ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
- ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.
- THE LENGTH OF SUPPORT SHALL BE ADJUSTED TO MAINTAIN THE REQUIRED ELEVATION MARKED IN LIGHTING LAYOUT.
- THE LOCATION AND SIZE OF JUNCTION BOX IS INDICATIVE ONLY. FIELD ENGINEER MAY LOCATE AS PER SITE CONDITION.

FOR TENDER PURPOSE ONLY

ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19	DWG. NO. 18A09-DWG-E-0800	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE	SHT. 09 OF 25	
2X500MW THERMAL POWER PLANT AT TUTICORIN						



DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS

JOB NO. 18A09

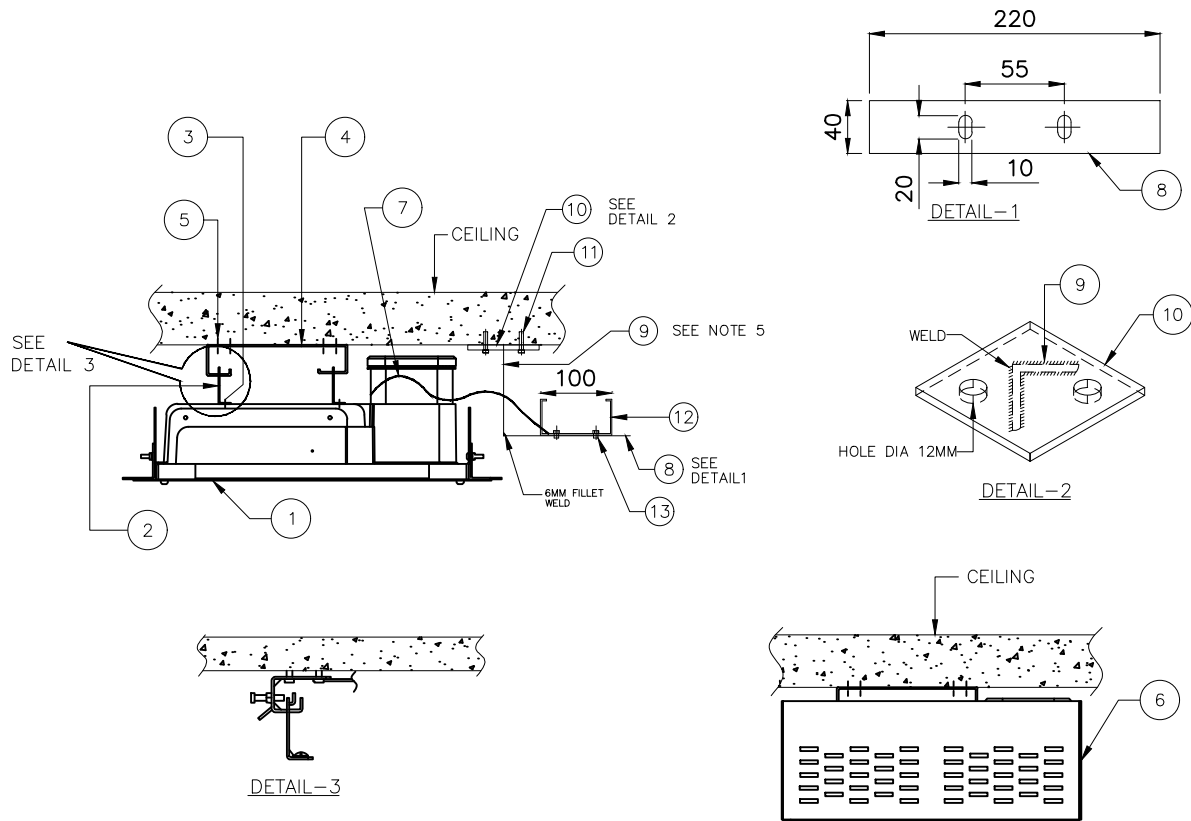
SCALE : NTS

DWG. NO. 18A09-DWG-E-0800

SHT. 09 OF 25

REV.

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ELECTRICAL INSTALLATION OF SURFACE MOUNTED GREEN BAY 165W OR EQUIVALENT LUMINAIRE FROM CEILING, TYPE LM

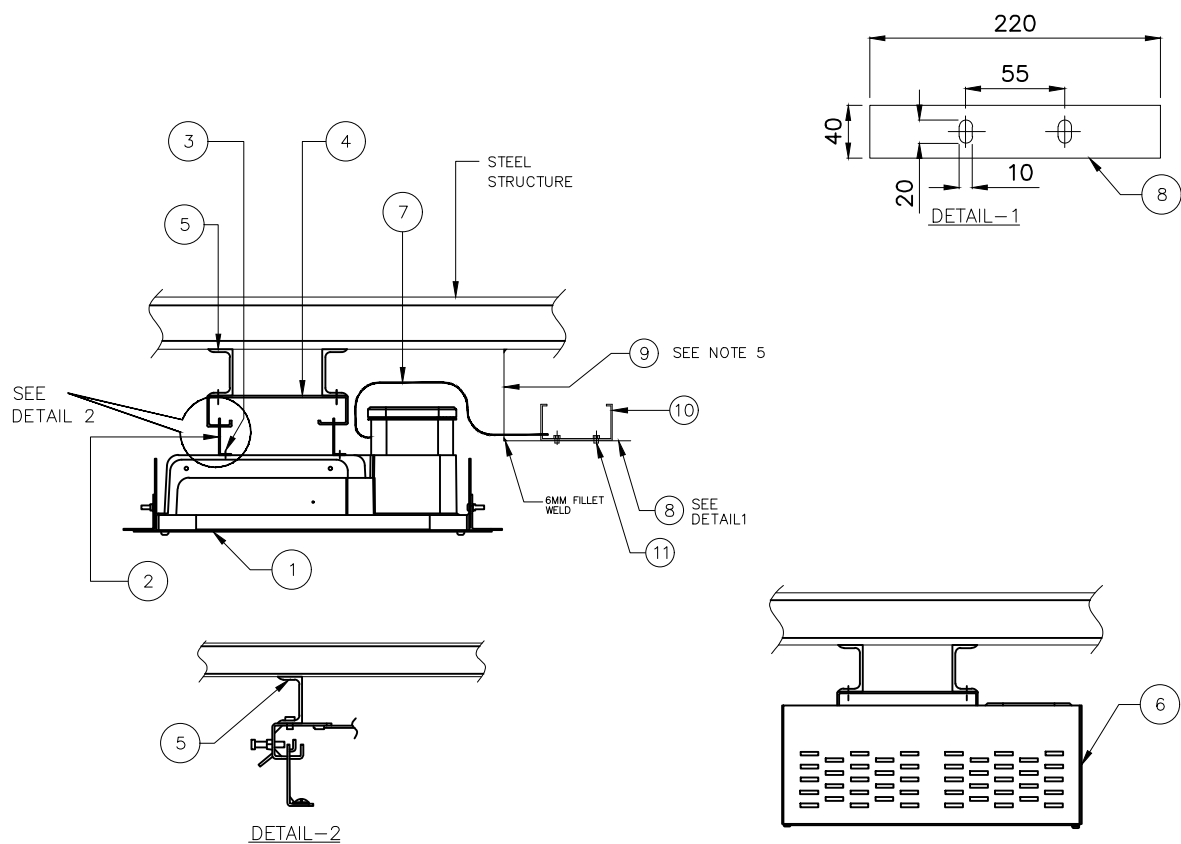
ITEM No.	DESCRIPTION	QUANTITY
1	MEDIUM OR HIGHBAY LUMINAIRE GREENBAY LED 135S CW SK PSU SI FGWH OR EQUIVALENT	1 NO.
2	LUM BRACKET	2 NOS.
3	M5 SCREW	4 NOS.
4	CEILING BRACKET	1 NO.
5	M6 SCREW	6 NOS.
6	JACKET	1 NO.
7	CABLE - 1.1kv 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
8	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	1 EACH
9	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
10	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
11	S10M RED HEAD ANCHOR AND BOLTS	2 EACH
12	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
13	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	2 EACH

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm).
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
3. ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
4. ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.

FOR TENDER PURPOSE ONLY

ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0800	REV. -
DS	SM	BG	-	12.02.19	SHT. 10 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE		



**ELECTRICAL INSTALLATION OF SURFACE MOUNTED GREEN BAY
165W OR EQUIVALENT LUMINAIRE FROM STEEL STRUCTURE, TYPE LM**

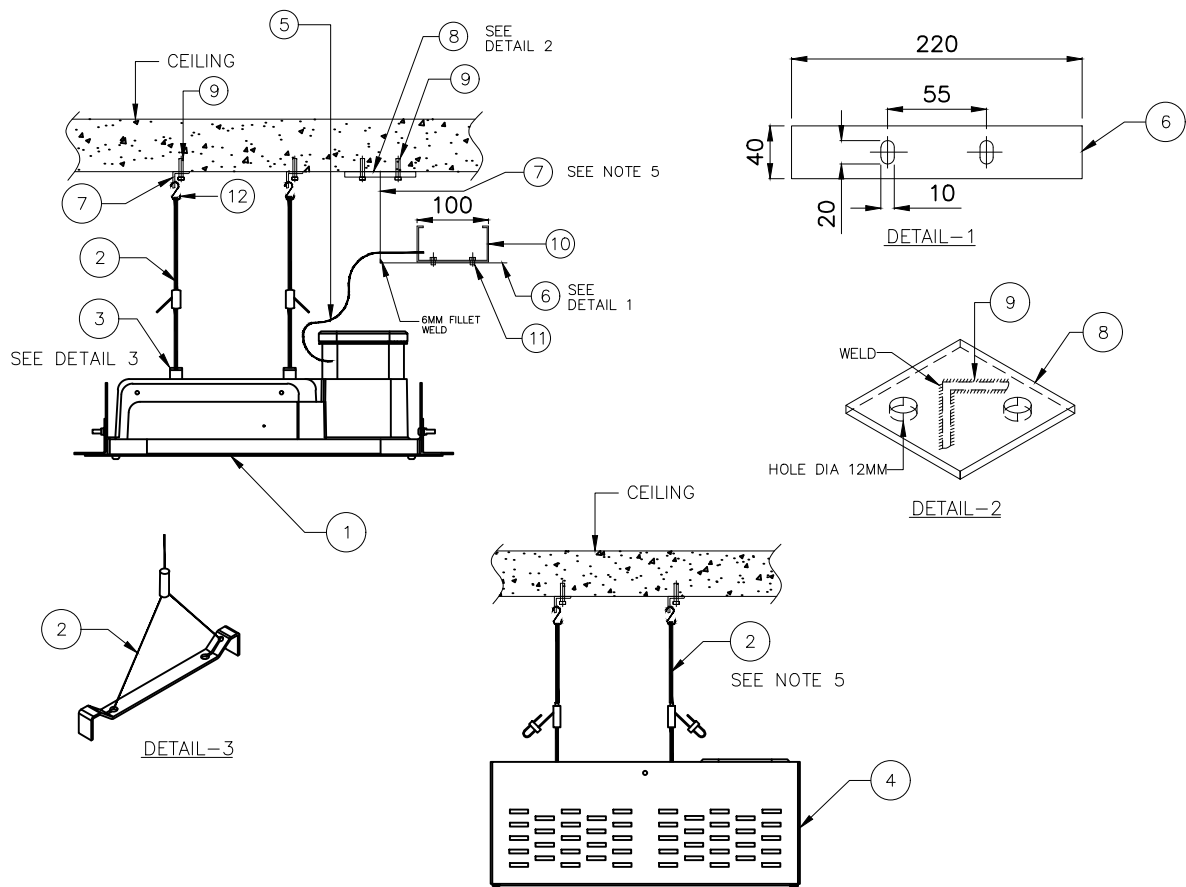
ITEM No.	DESCRIPTION	QUANTITY
1	MEDIUM OR HIGHBAY LUMINAIRE GREENBAY LED 135S CW SK PSU SI FGWH OR EQUIVALENT	1 NO.
2	LUM BRACKET	2 NOS.
3	M5 SCREW	4 NOS.
4	CEILING BRACKET	1 NO.
5	ISMC 100	AS REQUIRED
6	JACKET	1 NO.
7	CABLE - 1.1kv 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
8	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	1 EACH
9	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
10	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
11	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	2 EACH

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm).
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
3. ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
4. ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.

FOR TENDER PURPOSE ONLY

						ILLUMINATION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE				DWG. NO. 18A09-DWG-E-0800 SHT. 11 OF 25	
								REV. -	



**ELECTRICAL INSTALLATION OF SUSPENDED GREEN BAY 165W
OR EQUIVALENT LUMINAIRE, TYPE LM**

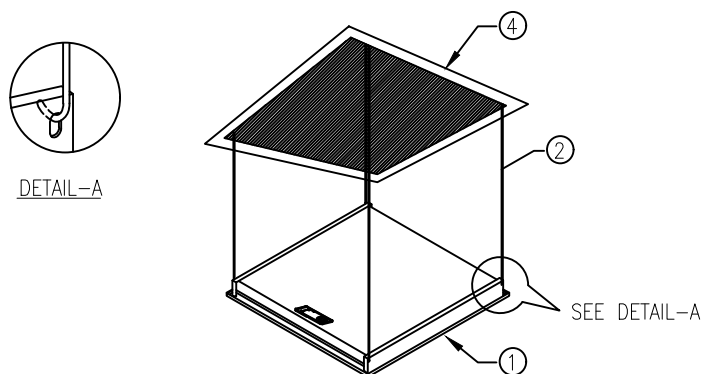
ITEM No.	DESCRIPTION	QUANTITY
1	MEDIUM OR HIGHBAY LUMINAIRE GREENBAY LED 135S CW SK PSU SI FGWH OR EQUIVALENT	1 NO.
2	CLUTCH WIRE	AS REQUIRED
3	BRACKET	2 NOS.
4	JACKET	1 NO.
5	CABLE - 1.1kV 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
6	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	1 EACH
7	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
8	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
9	S10M RED HEAD ANCHOR AND BOLTS	4 EACH
10	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
11	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	2 EACH
12	S-HOOK	2 EACH

NOTES :-

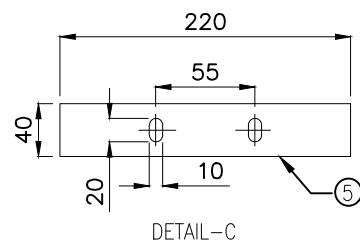
1. ALL DIMENSIONS ARE IN MILLIMETERS (mm).
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
3. ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
4. ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.
5. THE LENGTH OF SUPPORT (CLUTCH WIRE) SHALL BE ADJUSTED TO MAINTAIN THE REQUIRED ELEVATION MARKED IN LIGHTING LAYOUT.

FOR TENDER PURPOSE ONLY

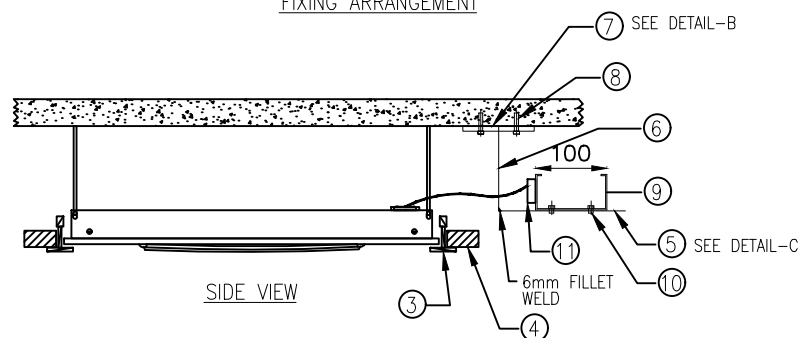
						 NLC TAMILNADU POWER LIMITED	  DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	JOB NO. 18A09		SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0800		REV.		
APPVD.	REVWD.	CHKD.	REV.	DATE							
							SHT. 12 OF 25		-		



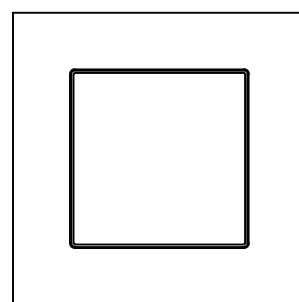
LIGHTING FIXTURE
FIXING ARRANGEMENT



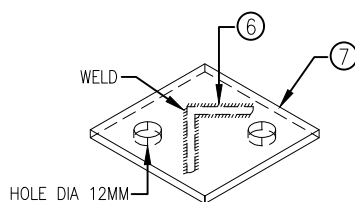
DETAIL-C



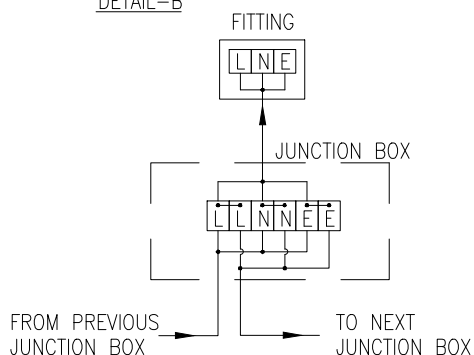
SIDE VIEW



LIGHTING FIXTURE
TOP VIEW



DETAIL-B



WIRING DIAGRAM

**ELECTRICAL INSTALLATION OF RECESSED
MOUNTED LUMINAIRE IP 20, SUITABLE FOR
2x2 GRID(600mm X 600mm) CIRBUS OR EQUIVALENT (TYPE-LG)**

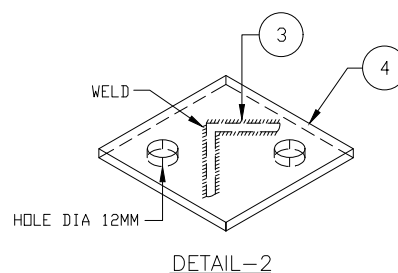
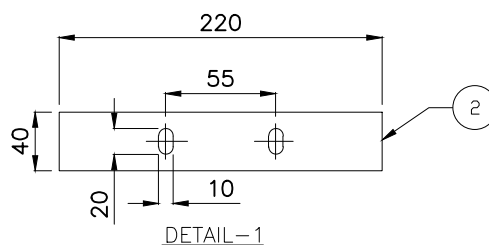
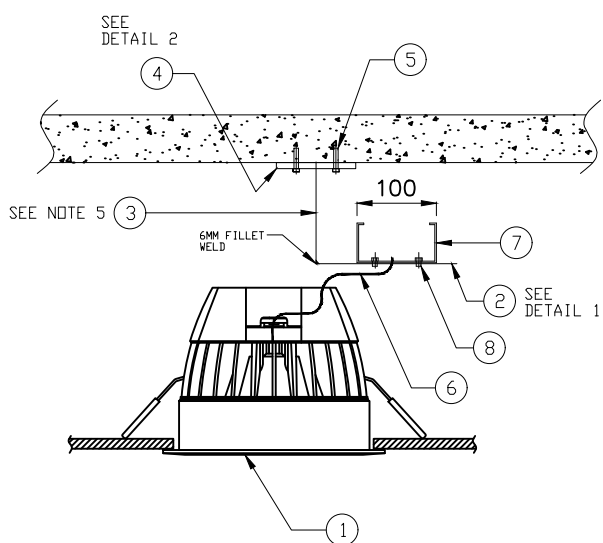
ITEM NO.	DESCRIPTION	QTY.
1	RECESSED MOUNTED LUMINAIRE-CIEEUS RC 365B LED22 4000 PSU OD WH OR EQUIVALENT	1 NO
2	CHAIN	AS REQUIRED
3	T- SECTION OF THE CEILING STRUCTURE	AS REQUIRED
4	FALSE CEILING	AS REQUIRED
5	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	2 EACH
6	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
7	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
8	S10M RED HEAD ANCHOR AND BOLTS	2 EACH
9	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
10	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	2 EACH
11	JUNCTION BOX	1 NO

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm)
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANIZED OR ZINC PASSIVATED
3. ALL SHARP EDGES AND BURRS SHALL BE REMOVED
4. AFTER DRILLING, THE CHANNEL IS TO BE PREPARED, PRIMED AND PAINTED.

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		SHT. 13 OF 25	-



MOUNTING IN FALSE CEILING

ELECTRICAL INSTALLATION OF RECESSED MOUNTED GREEN LED DOWN LIGHT 2x24W/2x15W, TYPE LD

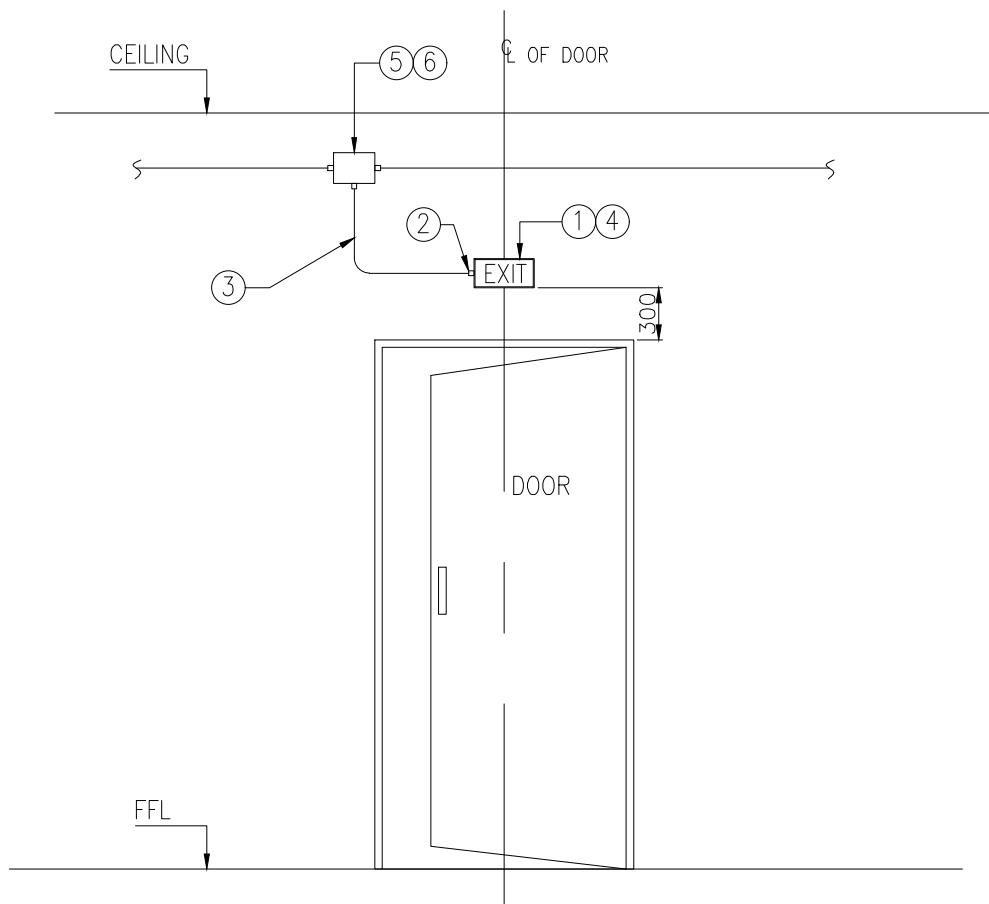
ITEM No.	DESCRIPTION	QUANTITY
1	CFL DOWNLIGHTER LUMINAIRE - 2x24W GREEN LED DNI94B LED15S-4000 PSU WH/2x15W GREEN LED DNI92B LED9S-4000 PSU WH OR EQUIVALENT	1 EACH
2	40x6x220mm LONG MILD STEEL FLAT, GALVANISED	1 EACH
3	50x50x6mm THK. MILD STEEL ANGLE, GALVANISED	AS REQUIRED
4	100x100x6mm THK. MILD STEEL PLATE, GALVANISED	1 EACH
5	S10M RED HEAD ANCHOR AND BOLTS	2 EACH
6	CABLE - 1.1kV 3 CORE x 2.5sq.mm Cu SWA CABLE	1 METER
7	CABLE TRAY - 100mm WIDE MILD STEEL, GALVANISED	AS REQUIRED
8	M6x25mm LONG MILD STEEL PAN HEAD SCREW COMPLETE WITH NUT & WASHER	AS REQUIRED

NOTES :-

- ALL DIMENSIONS ARE IN MILLIMETERS (mm).
- ALL NUTS, BOLTS, WASHERS SHALL BE GALVANISED OR ZINC PLATED.
- ALL SHARP EDGES AND BURRS SHALL BE REMOVED.
- ALL DAMAGE TO GALVANISED FINISHES SHALL BE MADE GOOD WITH ZINC RICH PAINT.
- THE LENGTH OF SUPPORT SHALL BE ADJUSTED TO MAINTAIN THE REQUIRED HEIGHT OF THE CABLE TRAY.

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800 SHT. 14 OF 25	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



EMERGENCY EXIT LIGHTING SIGN

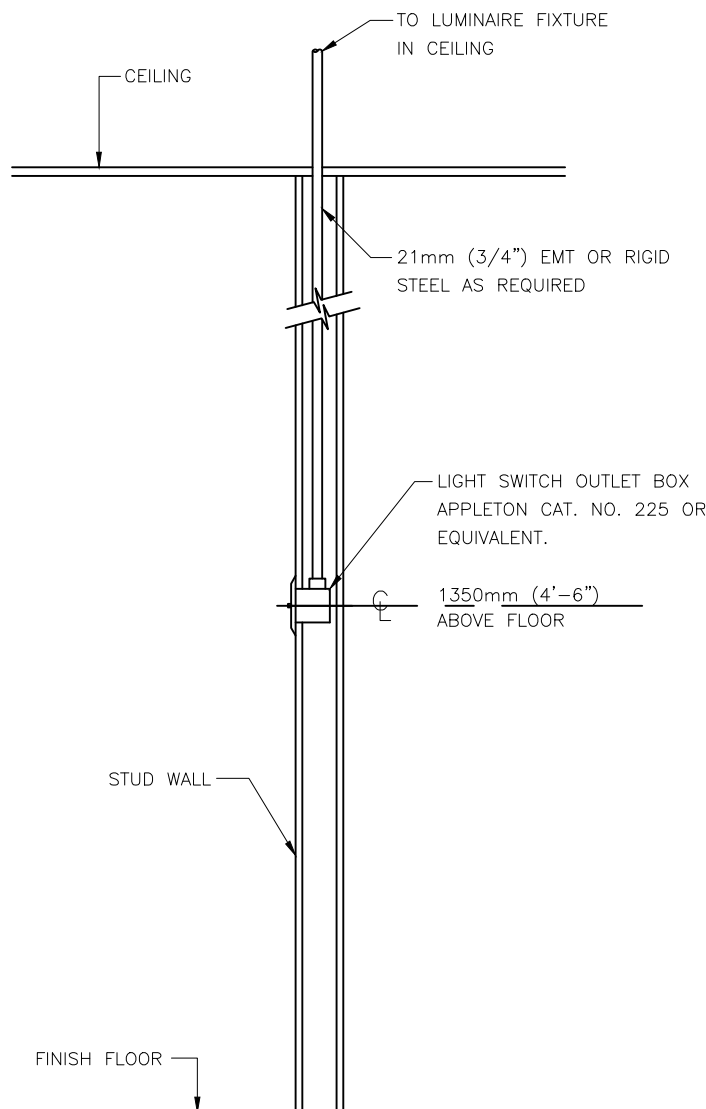
NOTES:

1. ALL DIMENSIONS ARE IN MILIMETERS (mm)
2. ALL NUTS, BOLTS, WASHERS SHALL BE GALVANIZED OR ZINC PASSIVATED

ITEM NO.	DESCRIPTION
1	EMERGENCY EXIT SIGN
2	CABLE GLAND TO SUIT ITEM NO. 3
3	3Cx2.5 Sqmm XLPE, SWA CABLE
4	4.0 BRASS FIXING SCREW x 41 Lg.
5	JUNCTION BOX
6	M6x25mm Lg. MILD STEEL BOLT HEX. HEAD PLATED C/W NUT & WASHER

FOR TENDER PURPOSE ONLY

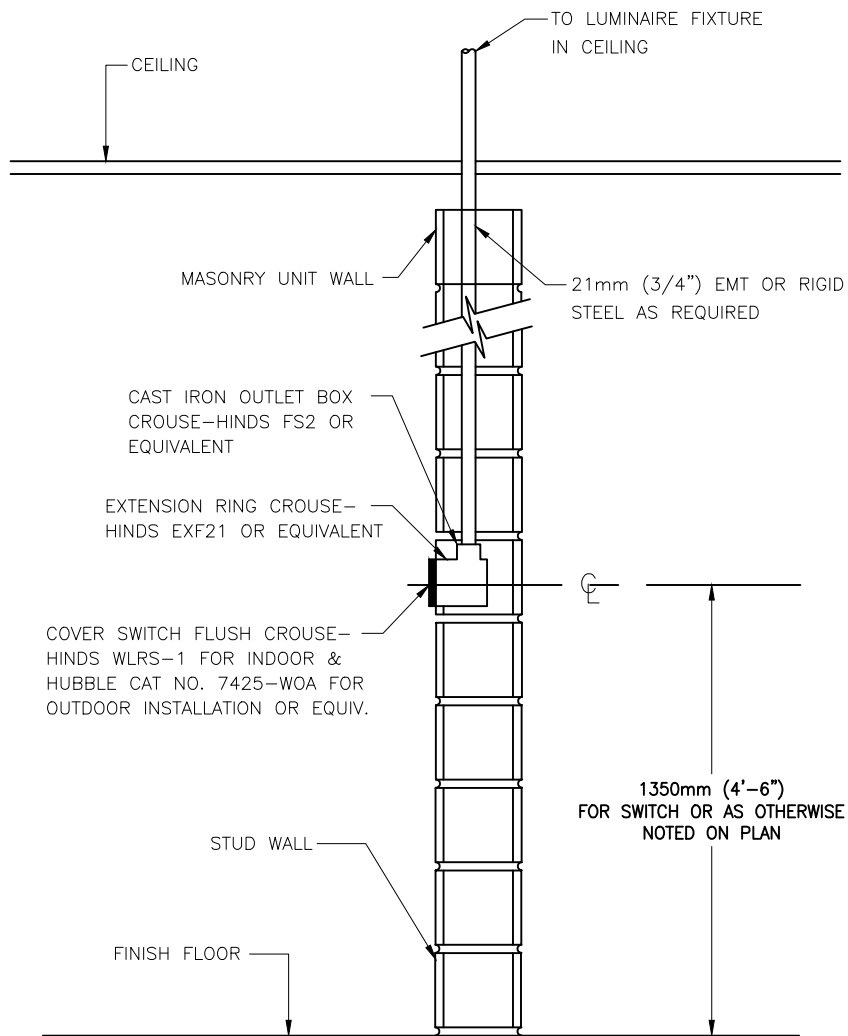
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						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09			SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800		REV.	
APPVD.	REVWD.	CHKD.	REV.	DATE			SHT. 15 OF 25		-	



FLUSH MOUNTED SWITCH BOX IN A STUD WALL

FOR TENDER PURPOSE ONLY

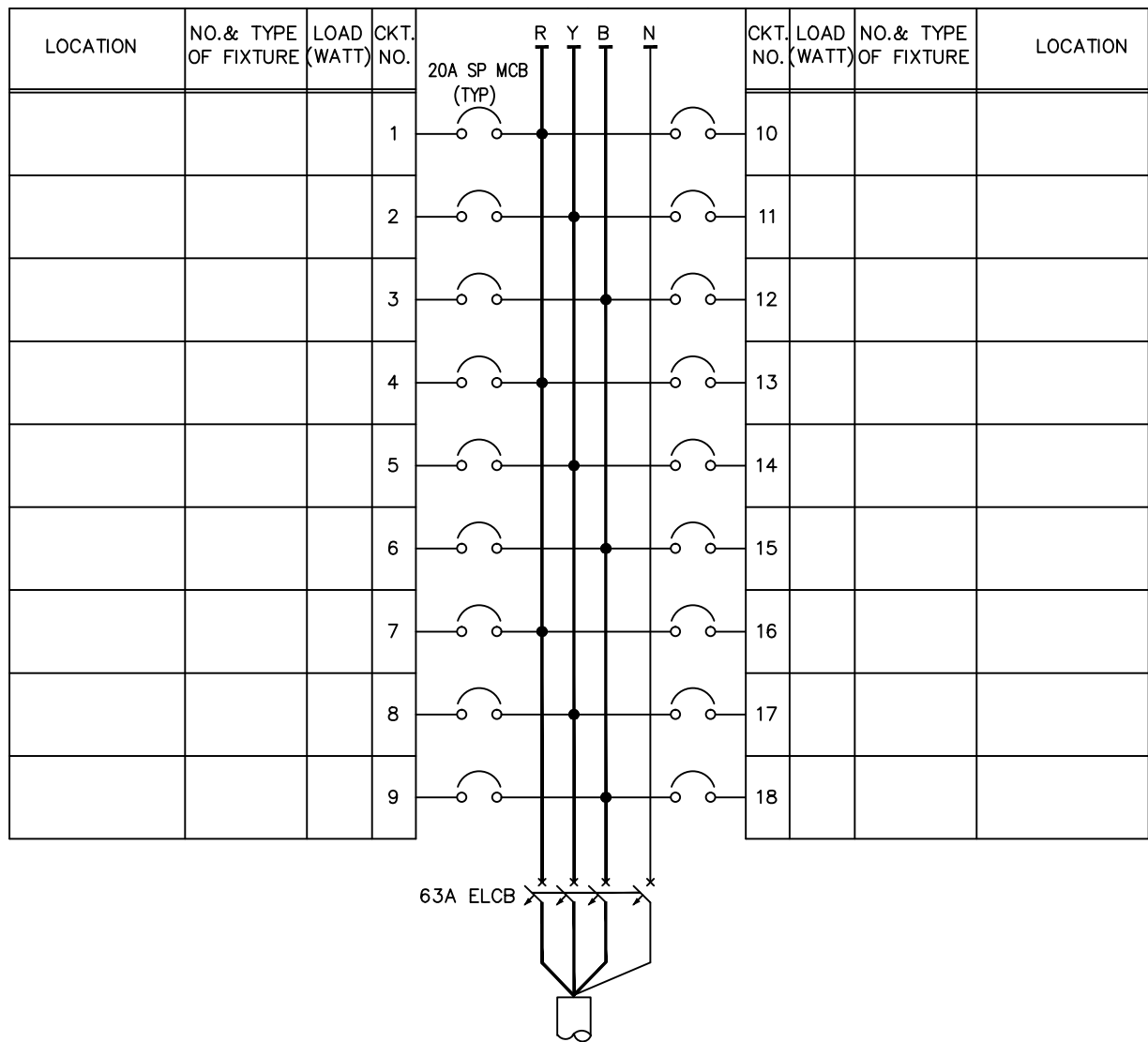
					ILLUMINATION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0800 SHT. 16 OF 25	
							REV. -	



FLUSH MOUNTED SWITCH BOX IN A BLOCK WALL

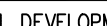
FOR TENDER PURPOSE ONLY

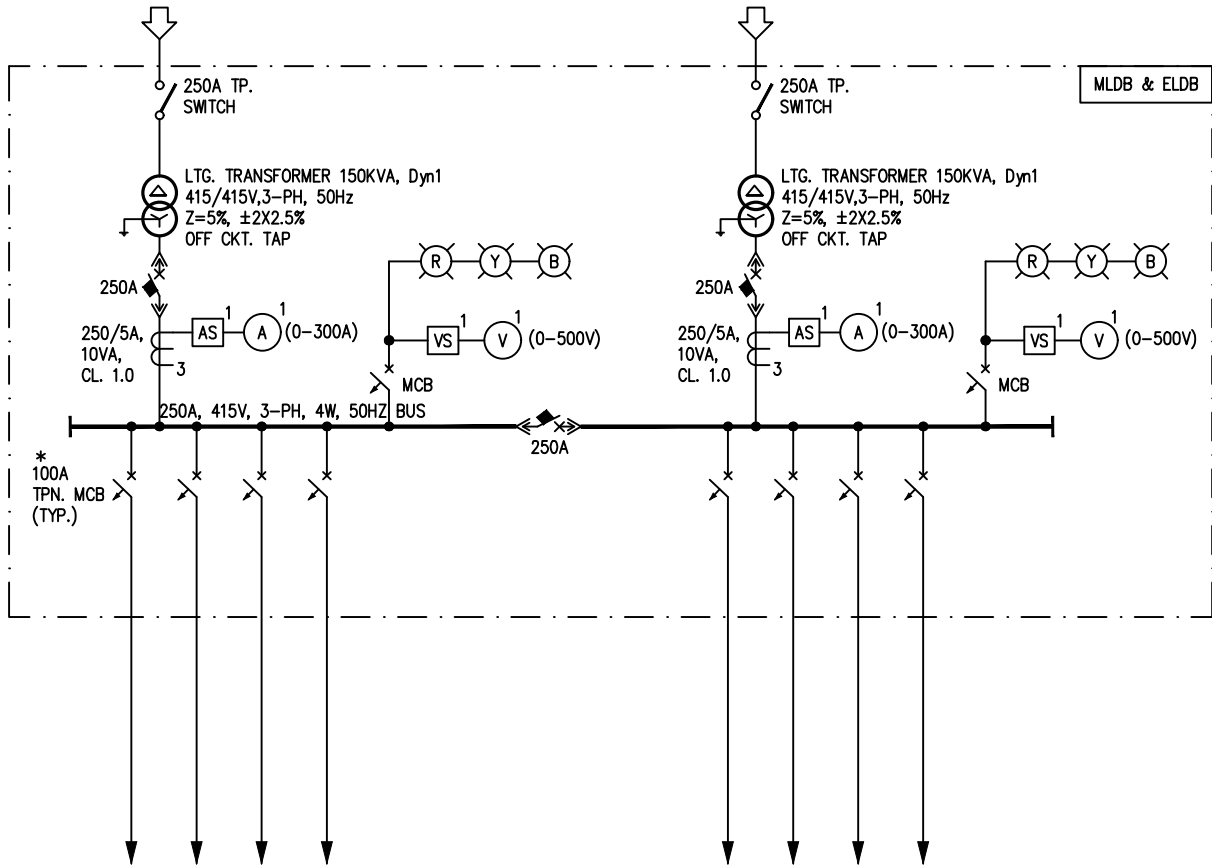
					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800 SHT. 17 OF 25	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



3-LINE DIAGRAM : LIGHTING PANEL

FOR TENDER PURPOSE ONLY

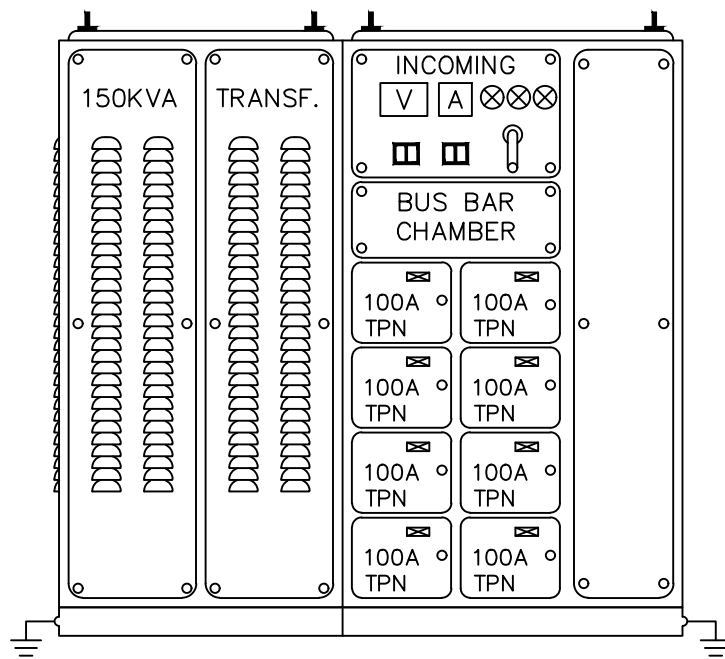
						 NLC TAMILNADU POWER LIMITED	  DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-0800 SHT. 18 OF 25	REV. -	



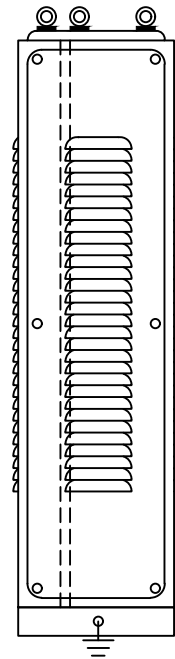
SLD : MAIN LIGHTING DISTRIBUTION BOARD

FOR TENDER PURPOSE ONLY

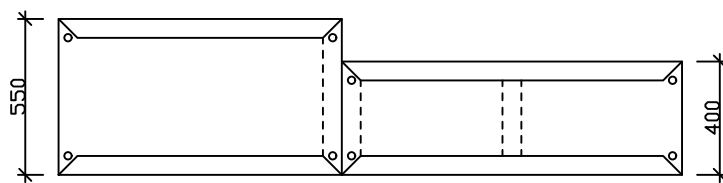
					 ILLUMINATION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0800 SHT. 19 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE			REV. -	



FRONT VIEW



SIDE VIEW

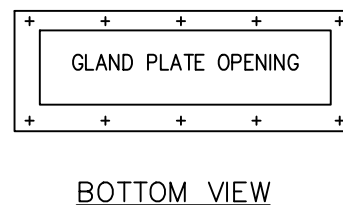
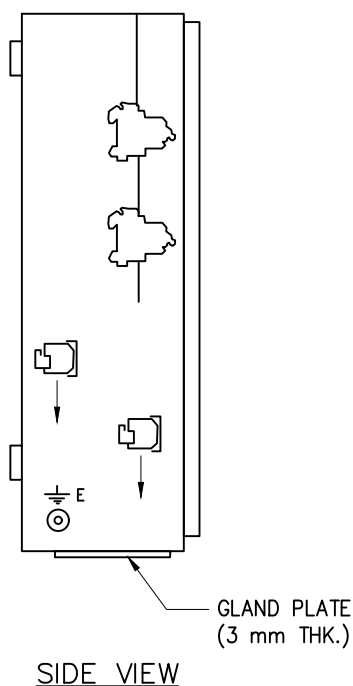
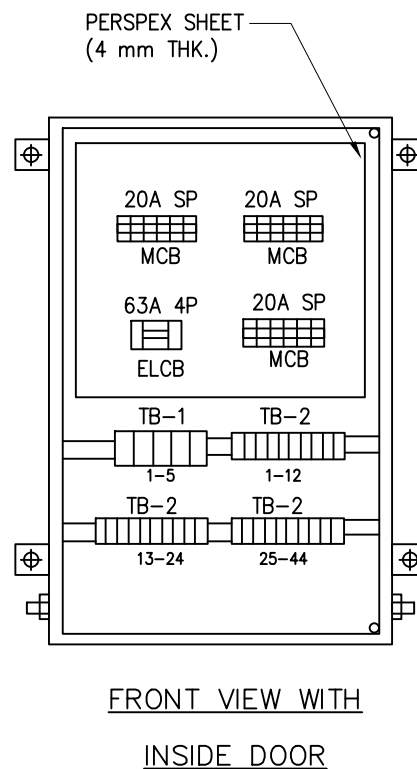
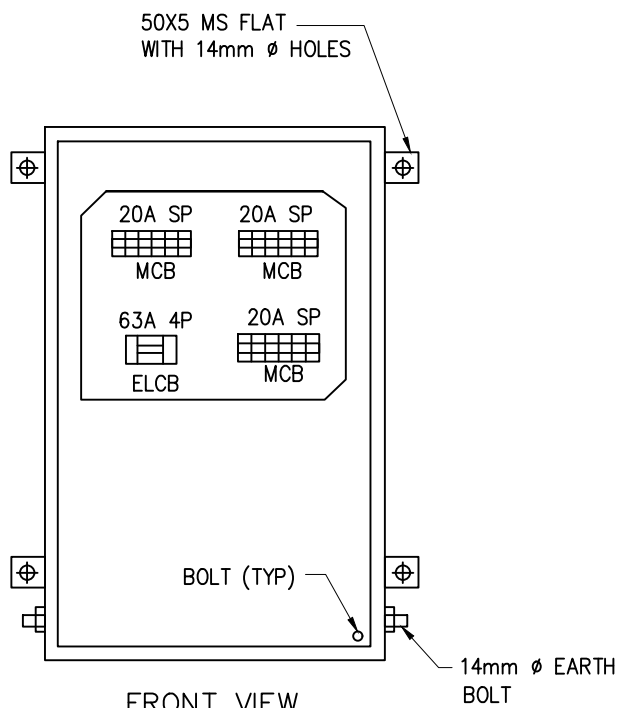


FOUNDATION PLAN

TYPICAL GENERAL ARRANGEMENT : MAIN LIGHTING DISTRIBUTION BOARD

FOR TENDER PURPOSE ONLY

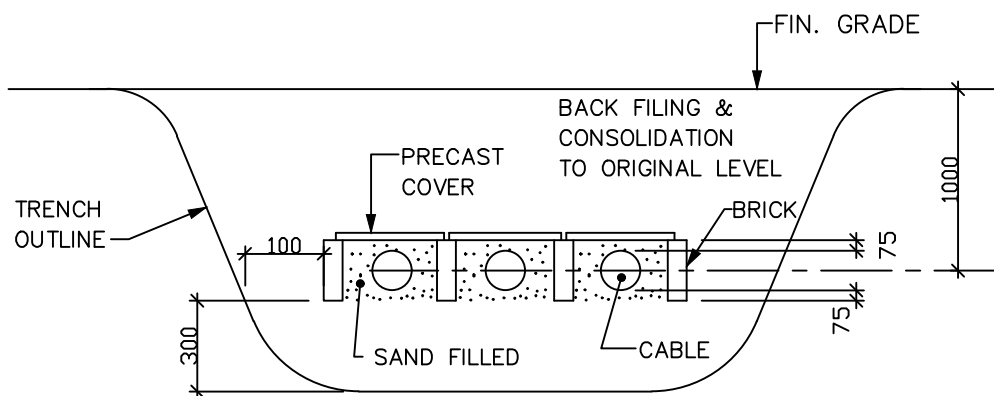
					 NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	JOB NO. 18A09		SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		DWG. NO. 18A09-DWG-E-0800		REV. SHT. 20 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE						



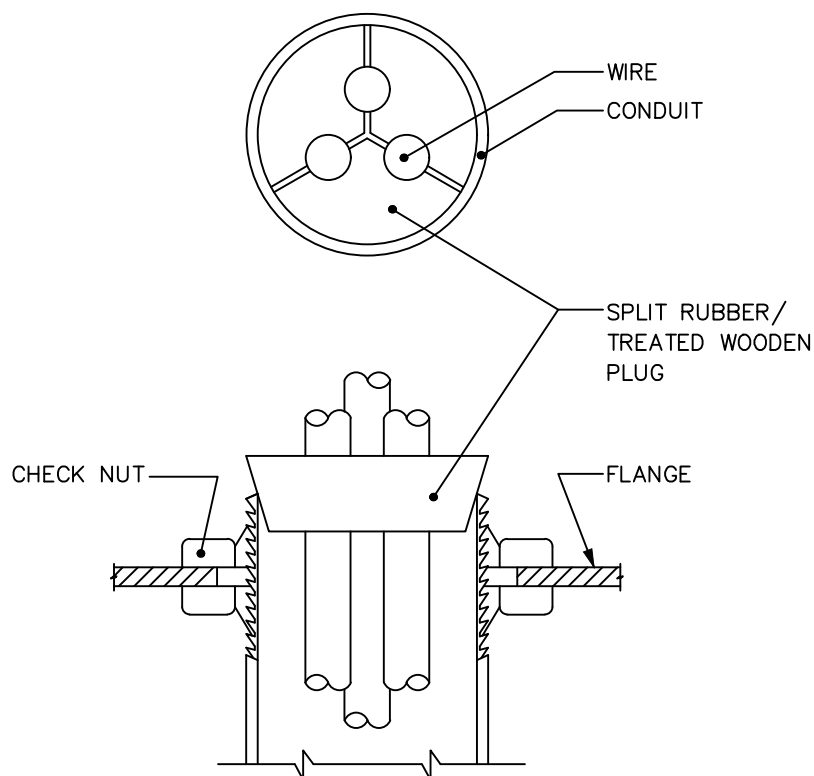
TTYPICAL GENERAL ARRANGEMENT DRAWING FOR LIGHTING PANEL

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. 18A09-DWG-E-0800	REV.
						SHT. 21 OF 25	-



TYP. DETAIL FOR BURIED CABLE



CLAMPING OF WIRES
IN CONDUIT VERTICAL RUN

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800 SHT. 22 OF 25 REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE		

1...FIXTURES ON STREET LIGHTING POLES SHALL BE FED FROM THE SLPs.

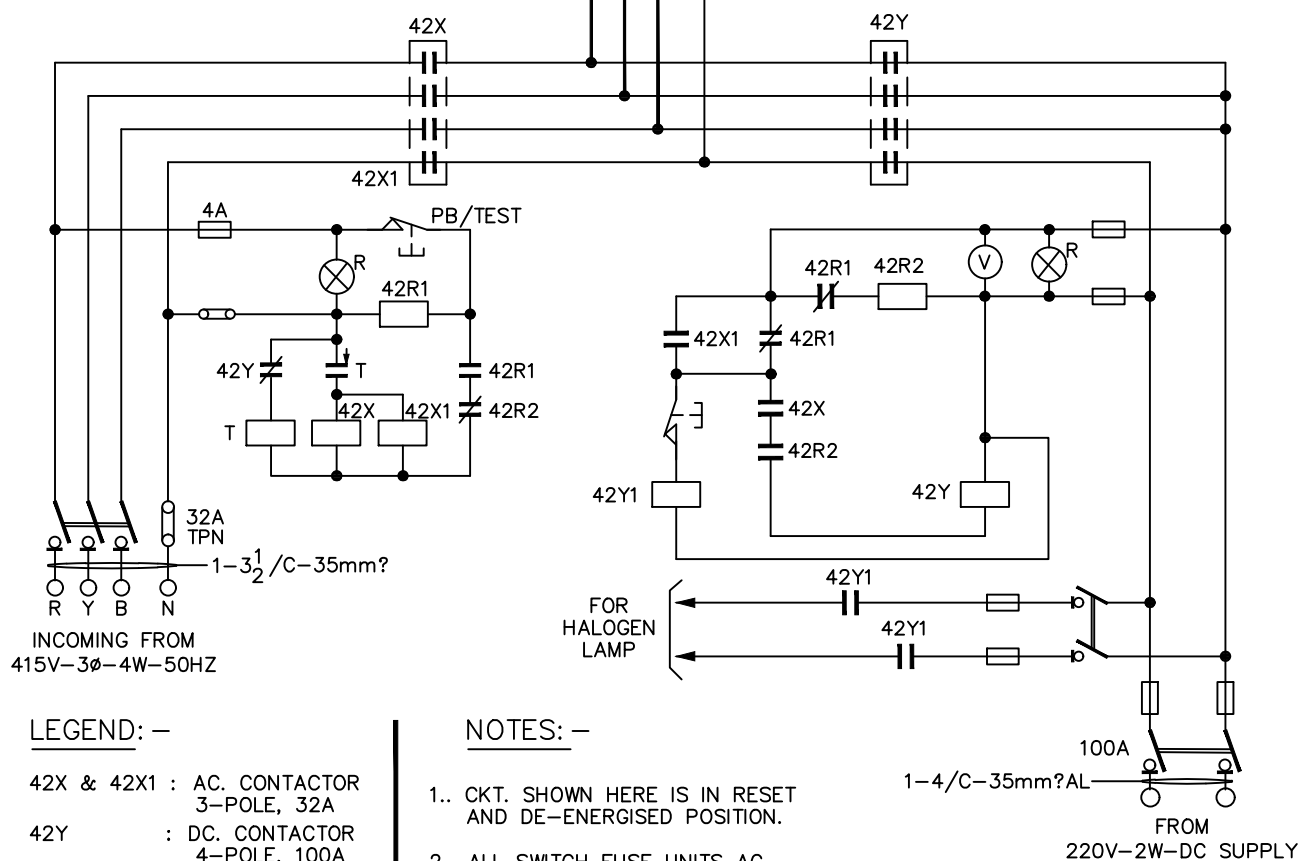
2...FIXTURES ON FLOOD LIGHTING TOWERS SHALL ALSO BE FED FROM THE SLPs VIA. ISOLATING SWITCH IN FLP MOUNTED AT THE BASE OF FLOOD LIGHTING TOWER.

FOR TENDER PURPOSE ONLY

					ILLUMINATION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-0800	REV.
APPVD.	REVWD.	CHKD.	REV.	DATE		SHT. 23 OF 25	-

415V-3 ϕ -4W-50HZ BUS
220V-2W-DC BUS

LOCATION	NO. & TYPE OF FIXTURE	LOAD (WATT)	CKT. NO.	20A MCB (TYP)	R	Y	B	N	CKT. NO.	LOAD (WATT)	NO. & TYPE OF FIXTURE	LOCATION
			1						2			
			3						4			
			5						6			
			7						8			
			9						10			
			11						12			

**LEGEND: -**

42X & 42X1 : AC. CONTACTOR
3-POLE, 32A
42Y : DC. CONTACTOR
4-POLE, 100A
42R1 : AUX. CONTACTOR
240V AC.
42R2 : AUX. CONTACTOR
220V DC
42Y1 : AUX. CONTACTOR
220V DC.
T : TIMER

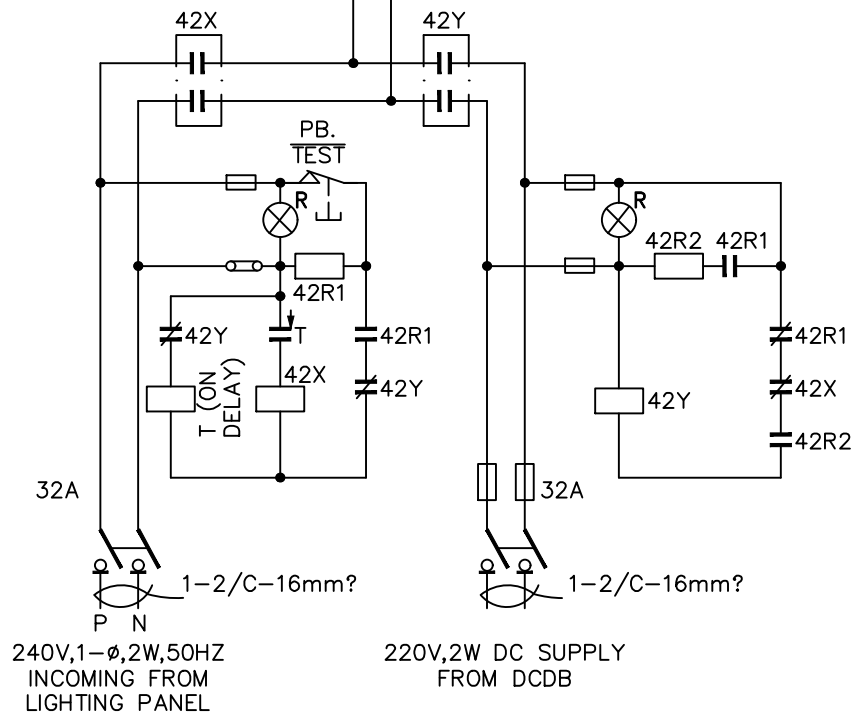
NOTES: -

- 1.. CKT. SHOWN HERE IS IN RESET AND DE-ENERGISED POSITION.
- 2.. ALL SWITCH FUSE UNITS AC AND DC. CONTACTORS, RELAYS, LAMPS, METERS SHOWN IN THIS DRG. SHALL BE FURNISHED WITH EMERGENCY LTG. BOARD.
- 3.. THE FAULT LEVEL SHALL BE WITHIN AVAILABLE MCB.

SCHEMATIC : EMERGENCY LTG. DIST. BOARD (3 ϕ)**FOR TENDER PURPOSE ONLY**

ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0800	REV. -
DS	SM	BG	-	12.02.19	SHT. 24 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE		

LOCATION	NO.& TYPE OF FIXTURE	LOAD (WATT)	CKT. NO.	220V,1- ϕ ,2W,50HZ BUS 220V,2W,DC BUS P ~ N	CKT. NO.	LOAD (WATT)	NO.& TYPE OF FIXTURE	LOCATION
			1		3			
			2		4			



LEGEND :-

42X : AC CONTACTOR, 2-POLE, 32A
 42Y : DC CONTACTOR, 2-POLE, 32A
 42R1: AUX. CONTACTOR 240V AC.
 42R2: AUX. CONTACTOR 220V DC.
 T : TIMER

NOTES :-

1. CKT. SHOWN HERE IS IN RESET AND DE-ENERGISED POSITION.
2. ALL SWITCH FUSE UNITS, AC AND DC CONTACTORS, RELAYS, LAMPS, METERS SHOWN IN THIS DRG. SHALL BE FURNISHED WITH EMERGENCY LTG. BOARD.
3. THE FAULT LEVEL SHALL BE WITHIN AVAILABLE MCB.

SCHEMATIC : EMERGENCY LTG. DIST. BOARD (1 ϕ)

FOR TENDER PURPOSE ONLY

ILLUMINATION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-0800	REV. -
DS	SM	BG	-	12.02.19	SHT. 25 OF 25	
APPVD.	REVWD.	CHKD.	REV.	DATE		

LIGHTNING
PROTECTION
NOTES & DETAILS

DWG. NO. 18A09-DWG-E-1000

FOR TENDER PURPOSE ONLY

1.0 AIR TERMINATIONS

- 1.1 Vertical air terminal rods shall be installed on the top of all structured/buildings to be protected from lightning strokes.
- 1.2 Vertical air terminal except those for chimney shall be 20 mm dia galvanised steel rods. The projected length of the rods including mounting structure, if any, shall be as required to protect the objects, from lightning stroke. Air terminal rods provided on top of chimney/ stack for lightning protection shall be 20 mm dia lead coated solid copper rods.
- 1.3 Air terminal rods shall be properly fixed on top of buildings/ structures to withstand wind pressure. In case the air terminal rods are embedded in the building roof, the portion embedded in the concrete shall not touch the reinforcement bars and shall be duly insulated from them.
- 1.4 All vertical air terminal rods shall be electrically connected by means of horizontal conductors (galvanised MS flats) of size 50 x 6 mm.
- 1.5 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.
- 1.6 Horizontal air terminations (galvanised MS flats) shall be so laid out that no part of the roof is more than nine (9) metres away from the nearest Horizontal air terminals.

2.0 SHIELDING MASTS

- 2.1 The shielding mast for lightning protection shall be installed on top of the steel column cap plates of power house main building.
- 2.2 The shielding masts shall be made of galvanised steel pipe and the heights of the same shall be decided considering the zones to be protected.
- 2.3 Each shielding mast shall be connected to grounding grid of the station by a 50 x 6 mm. galvanised MS down conductor running along the building column. In addition, all power house building column joints shall be electrically bonded.

3.0 DOWN CONDUCTORS

- 3.1 The down conductors shall be 50 x 6 mm galvanised MS flats. However, The down conductor of conveyor gallery may be 25 x 4 mm galvanised MS flats.
One end of these flats shall be connected to the air terminal rods/ horizontal conductors on top of roof/structure and the other end to the nearest earth terminals.
- 3.2 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductors of the grounding system above ground

FOR TENDER PURPOSE ONLY

						LIGHTNING PROTECTION NOTES & DETAILS		DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS
						 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09	SCALE : NTS
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-1000 SHT. 01 OF 12	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE				

- 3.3 The connection between each down conductor and earth terminal shall be made via test link located at approximately 1500 mm above ground level.
- 3.4 The down conductors shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on the outside of the building wall and or columns/structures at intervals of about 750 mm., unless indicated otherwise in the drawings.
- 3.5 Down conductors along the chimney shell shall be electrically connected with the reinforcement rods by suitable lugs welded (6 mm fillet) to both down conductor and reinforcement at the interval of 30 mm.
- 3.6 All exposed metallic parts of a building shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

4.0 EARTH TERMINALS.

- 4.1 Where ground mat is available, the risers specifically ear-marked for lightning protection shall be considered as Earth Terminal. In such case, one electrode shall be provide close to the each Earth Terminals.
- 4.2 Where ground mat is not available sparate earth pit as per IS-3043 or approved international standard specifically for lightning protection shall be provided as Earth Terminal.

5.0 JOINTING & CONNECTION

- 5.1 Number of joints in the lightning conductors shall be kept to a minimum.
- 5.2 All the joints shall be done by arc welding process. Overlapping of conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be properly cleaned before jointing.
- 5.3 Those portions of galvanised steel flats, which have been welded at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.
- 5.4 After successful testing the bolted joints of test links shall be wrapped by bitumenous hessian tape followed by 3 mm thick coating of bitumen compound.
- 5.5 Air terminal rods and shielding masts shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).
- 5.6 Steel to copper connection shall be brazed type.

FOR TENDER PURPOSE ONLY

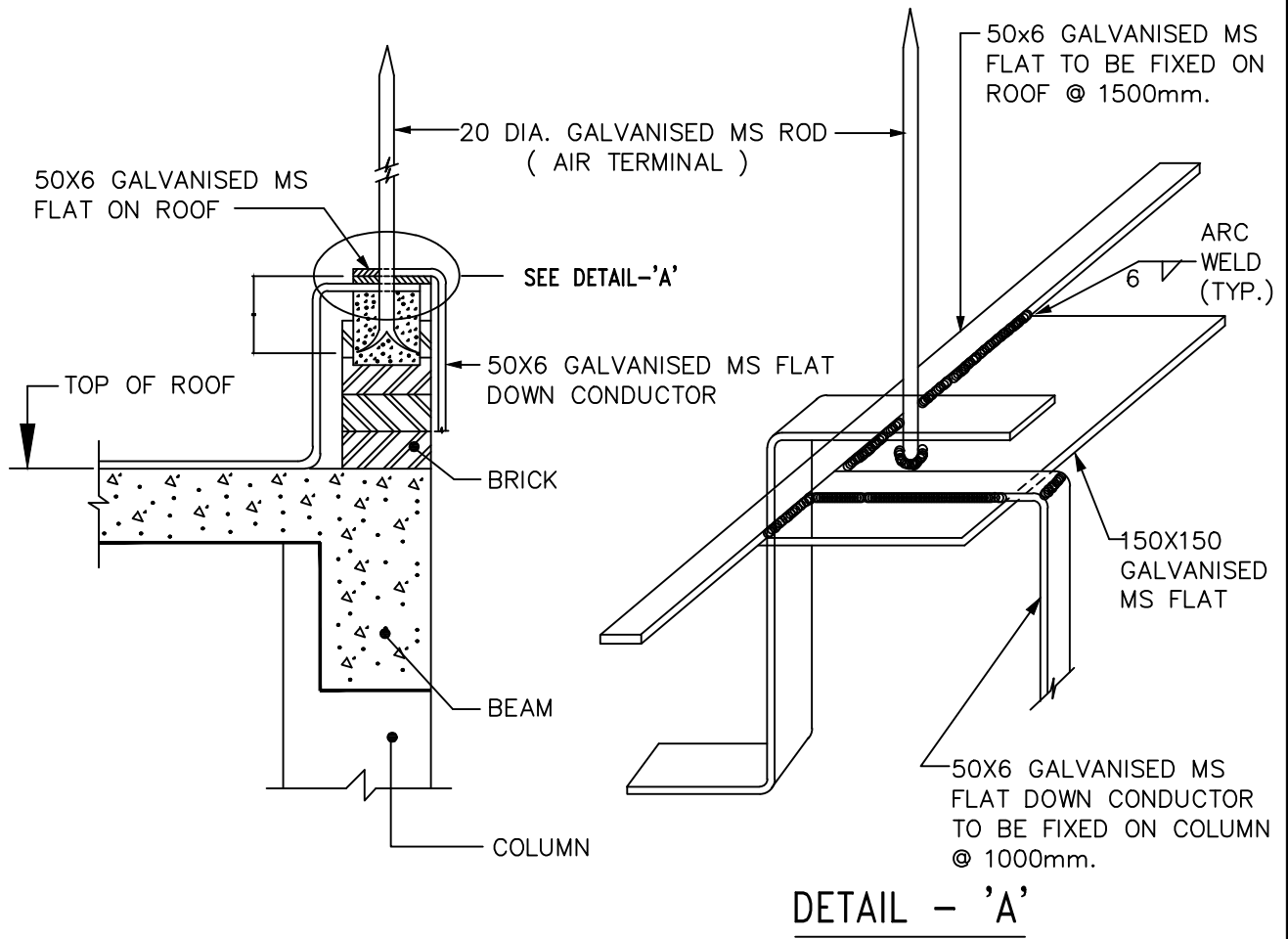
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						 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE				DWG. NO. 18A09-DWG-E-1000 SHT. 02 OF 12	
								REV. -	

18A09-DWG-E-1000 Sh. 03 OF 12 12.02.2019

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FOR TENDER PURPOSE ONLY

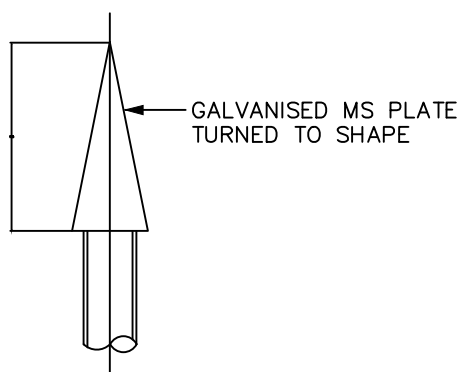
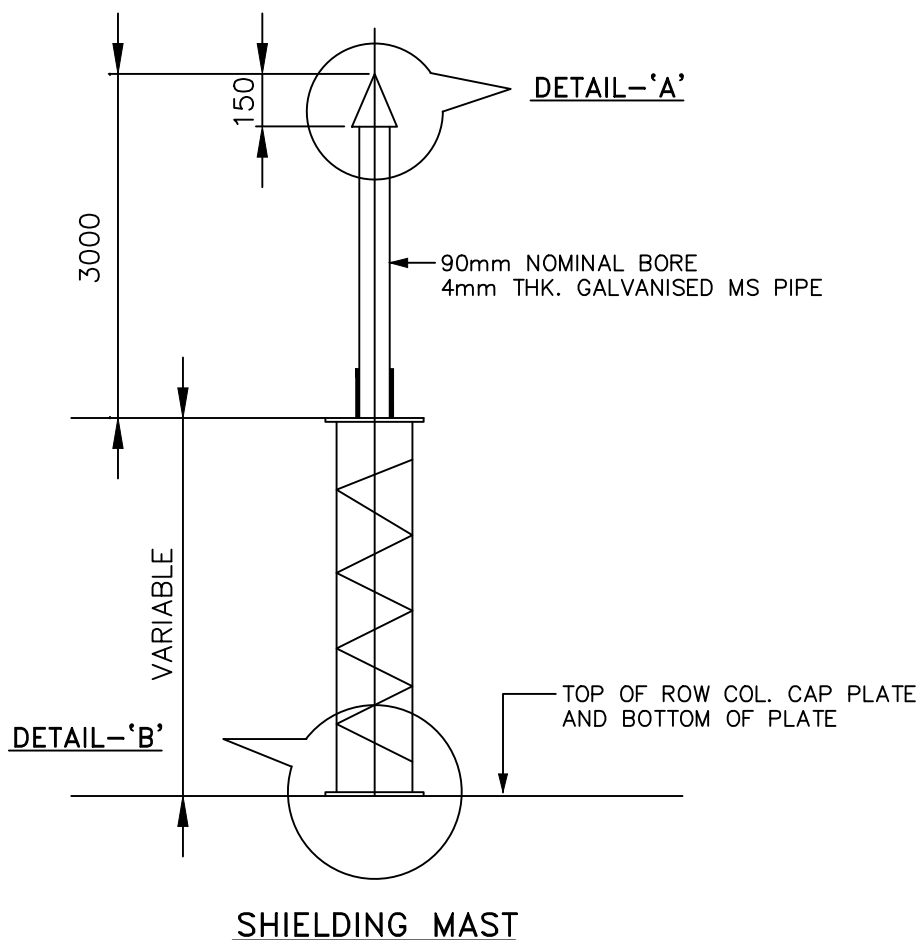
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						NLC TAMILNADU POWER LIMITED		CONSULTING ENGINEERS	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09	SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-1000	SHT. 03 OF 12	REV.



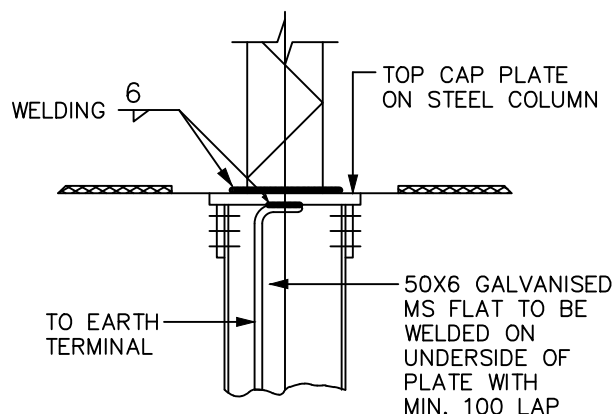
FIXING DETAILS OF AIR TERMINAL ROD
ON BUILDING ROOF
(FOR LIGHTNING PROTECTION)

FOR TENDER PURPOSE ONLY

					LIGHTNING PROTECTION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED	JOB NO. 18A09 SCALE : NTS	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-1000 SHT. 04 OF 12	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			



DETAIL - A

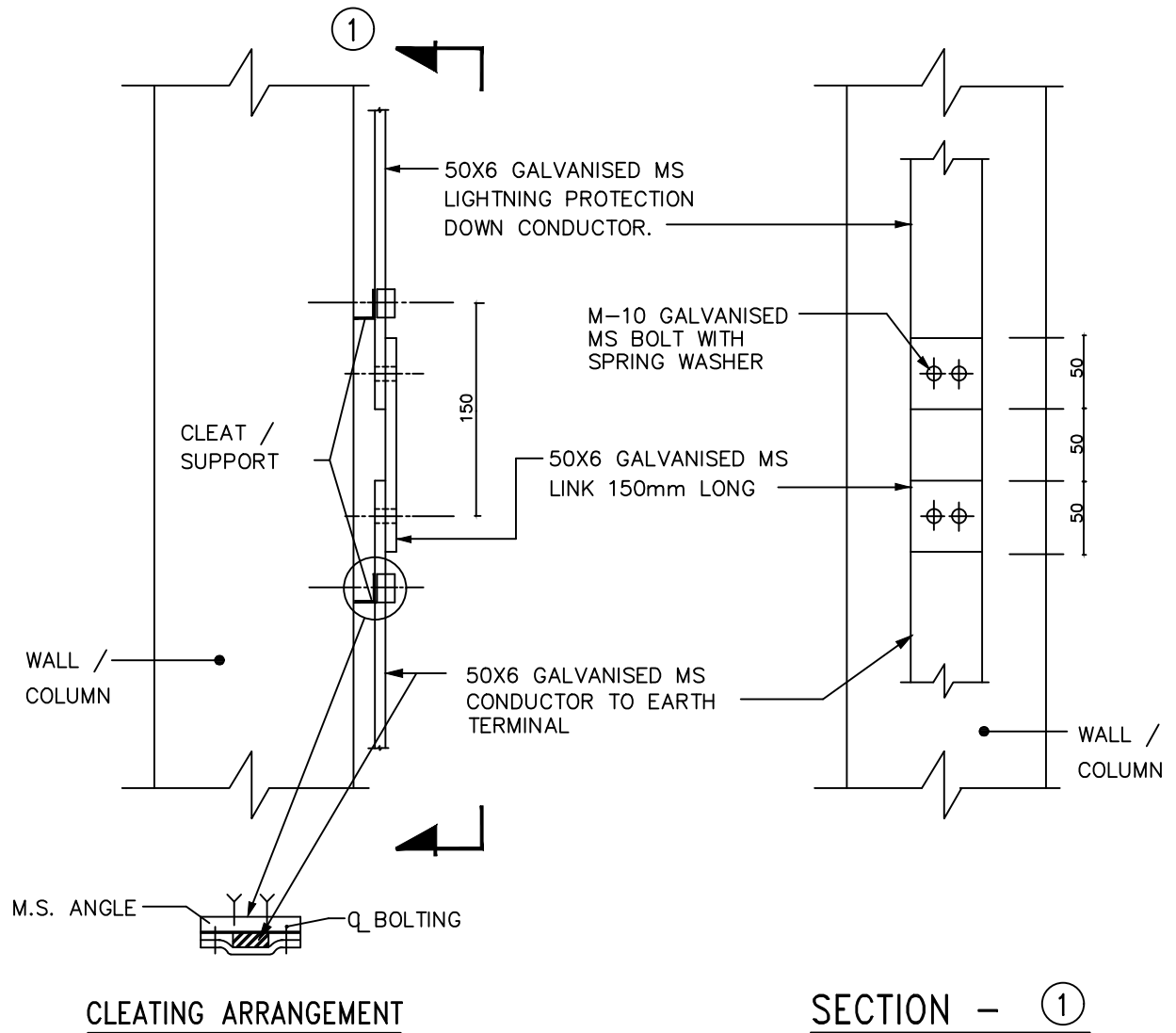


DETAIL - B

**FIXING DETAILS OF SHIELDING
MAST ON TOP OF STEEL COLUMNS
OF POWER HOUSE BUILDING
(FOR LIGHTNING PROTECTION)**

FOR TENDER PURPOSE ONLY

					LIGHTNING PROTECTION NOTES & DETAILS  NLC TAMILNADU POWER LIMITED	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS JOB NO. 18A09 DWG. NO. 18A09—DWG—E—1000 SHT. 05 OF 12	SCALE : NTS REV. -
DS	SM	BG	-	12.02.19			
APPVD.	REVWD.	CHKD.	REV.	DATE	2X500MW THERMAL POWER PLANT AT TUTICORIN		



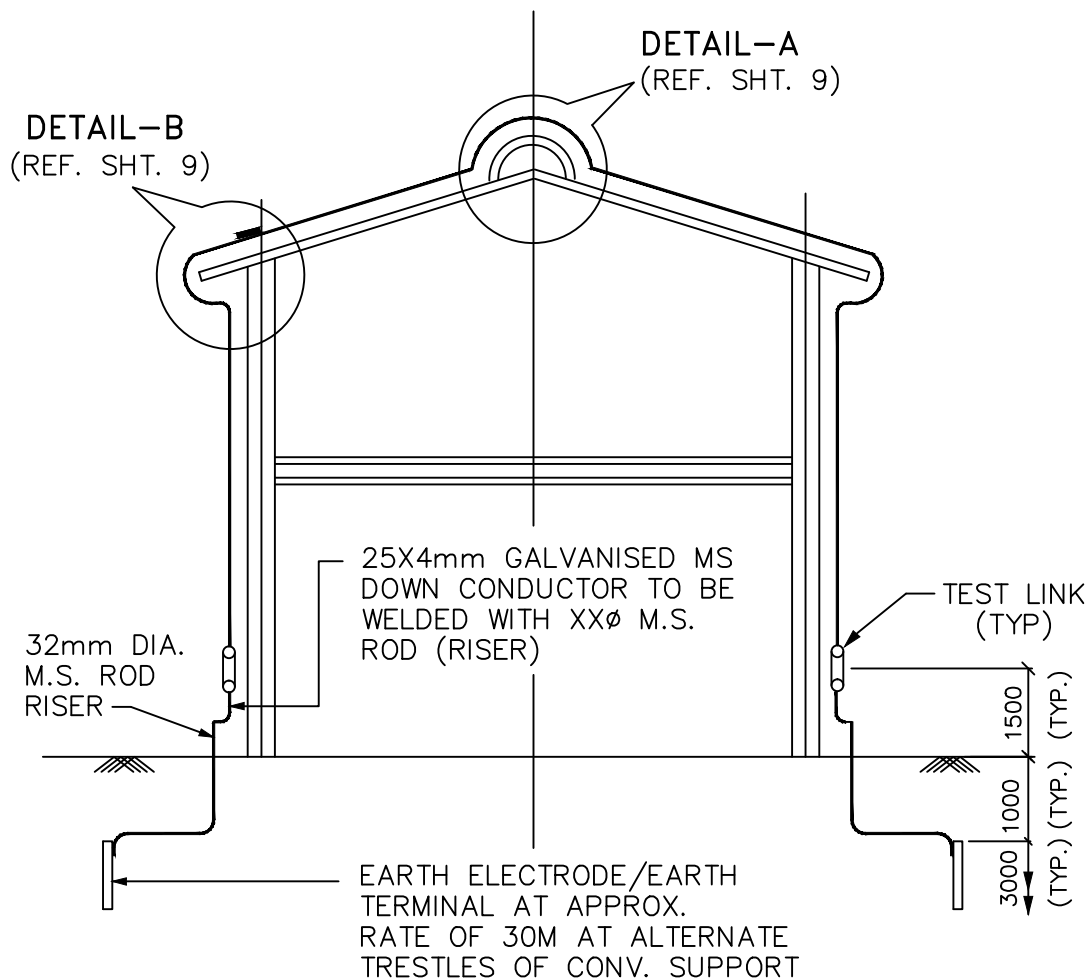
TEST LINK POINT / CLEATING ARRANGEMENT

NOTE :-

LINK POINT TO BE MOUNTED AT A HEIGHT OF 1.5M ABOVE GROUND LEVEL

FOR TENDER PURPOSE ONLY

					LIGHTNING PROTECTION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
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							REV. -	

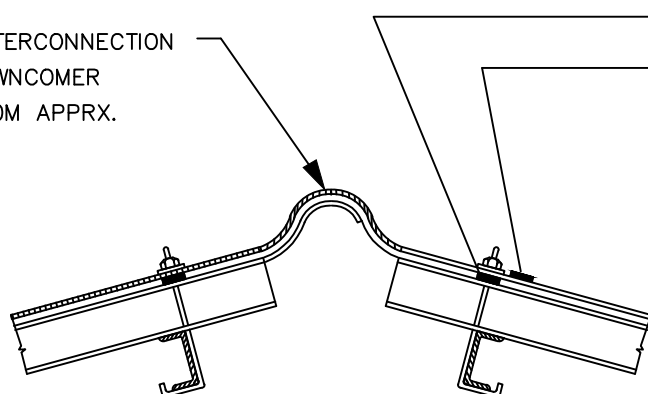


SECTION
(TYPICAL ARRANGEMENT OF DOWN
CONDUCTOR FOR CONV. GALLERY)

FOR TENDER PURPOSE ONLY

					LIGHTNING PROTECTION NOTES & DETAILS	 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
							 NLC TAMILNADU POWER LIMITED
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN	DWG. NO. 18A09-DWG-E-1000 SHT. 07 OF 12	REV. -
APPVD.	REVWD.	CHKD.	REV.	DATE			

FLAT INTERCONNECTION
FOR DOWNCOMER
AT @ 30M APPRX.

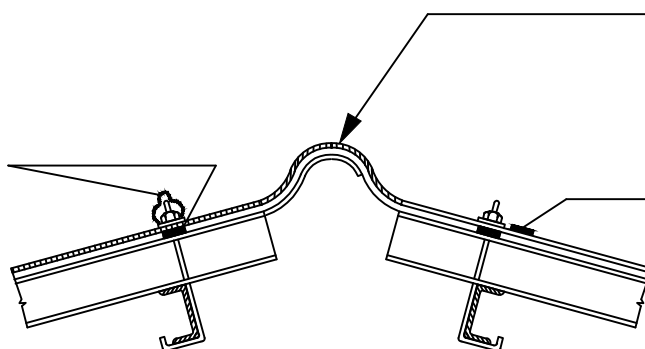


PRESSURE WASHER

25X4 GALVANISED MS
FLAT FOR HORIZONTAL
CONDUCTOR ALONG
LENGTH OF GALLERY

DETAIL-A
(FOR DOWNCOMER)

BITUMEN WASHER
AND PUTTY FOR
WATER SEALING
(TYP)



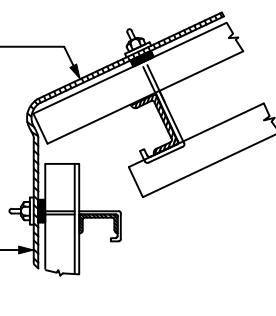
FLAT INTERCONNECTION
FOR DOWN COMER
AT @ 5M APPRX.

25X3 GALVANISED MS
FLAT FOR HORIZONTAL
CONDUCTOR ALONG
LENGTH OF GALLERY

DETAIL-A
(WITHOUT DOWNCOMER)

GALVANISED MS FLAT
INTERCONNECTION

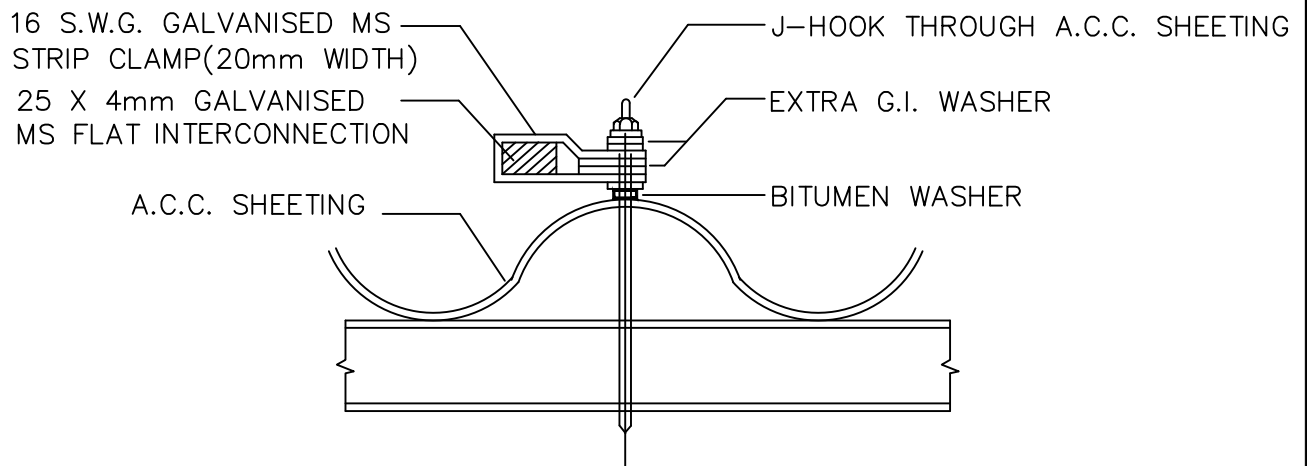
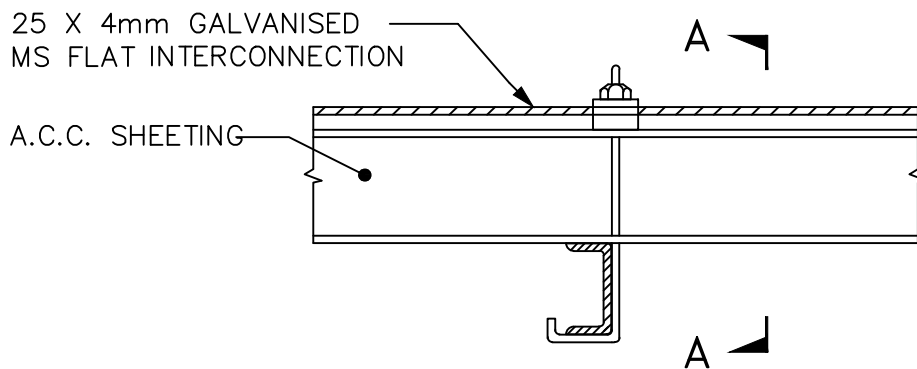
25X4 mm GALVANISED MS
FLAT DOWN CONDUCTOR
AT @ 30M APPRX.
ALONG TRESTLE



DETAIL-B

FOR TENDER PURPOSE ONLY

					LIGHTNING PROTECTION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
					 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19	2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-1000 SHT. 08 OF 12	
							REV. -	

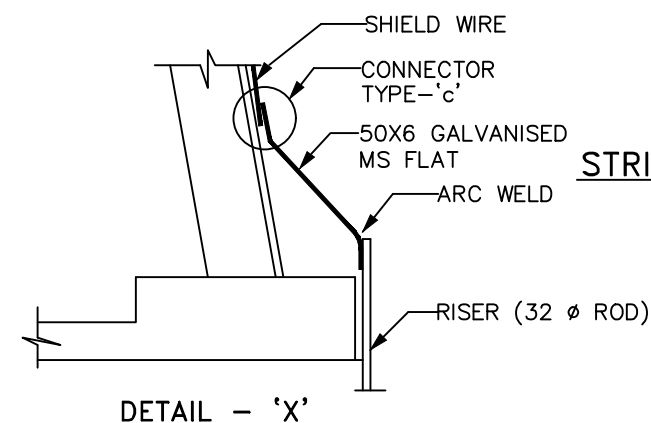
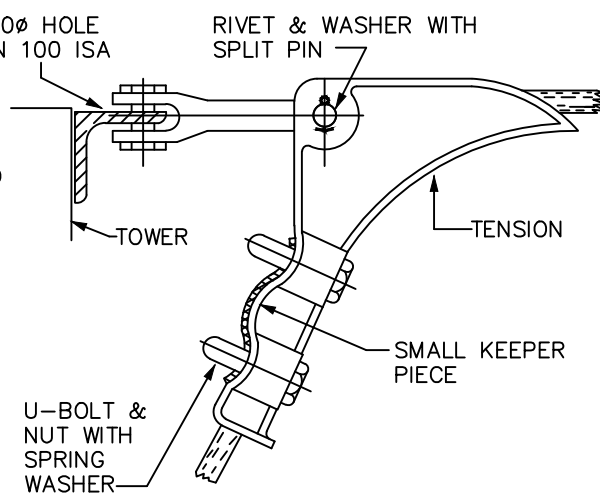
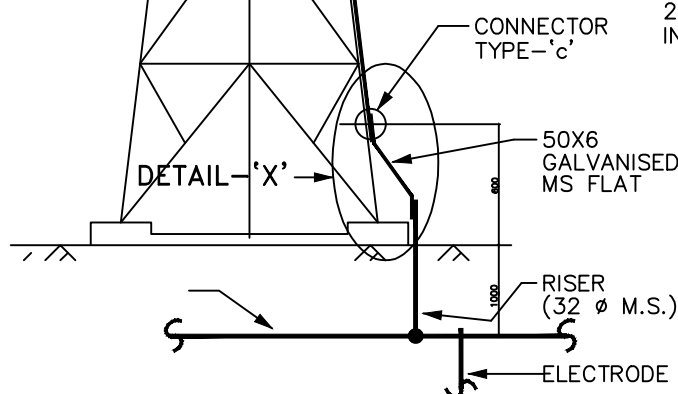
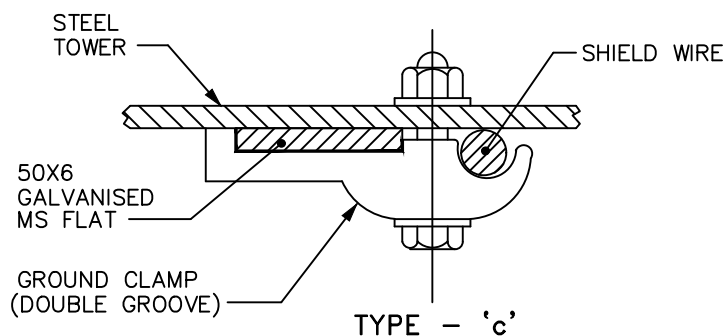
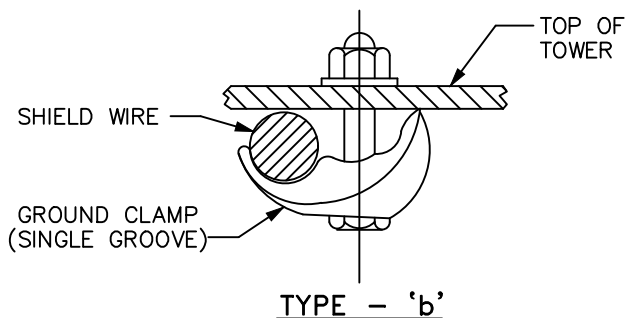
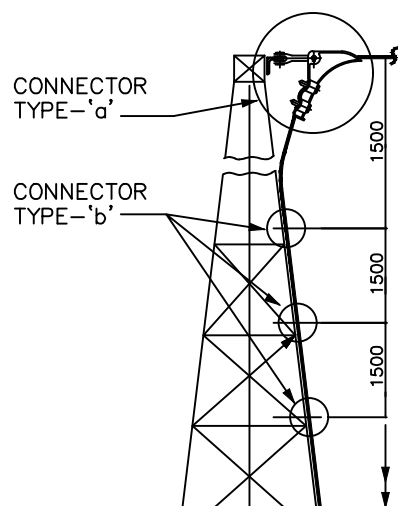


SECTION- A-A

TYPICAL FIXING ARRANGEMENT OF GALVANISED MS INTERCONNECTION FLAT ON ASBESTOS CEMENT CONCRETE (A.C.C) SHEETING (CONVEYOR GALLERY)

FOR TENDER PURPOSE ONLY

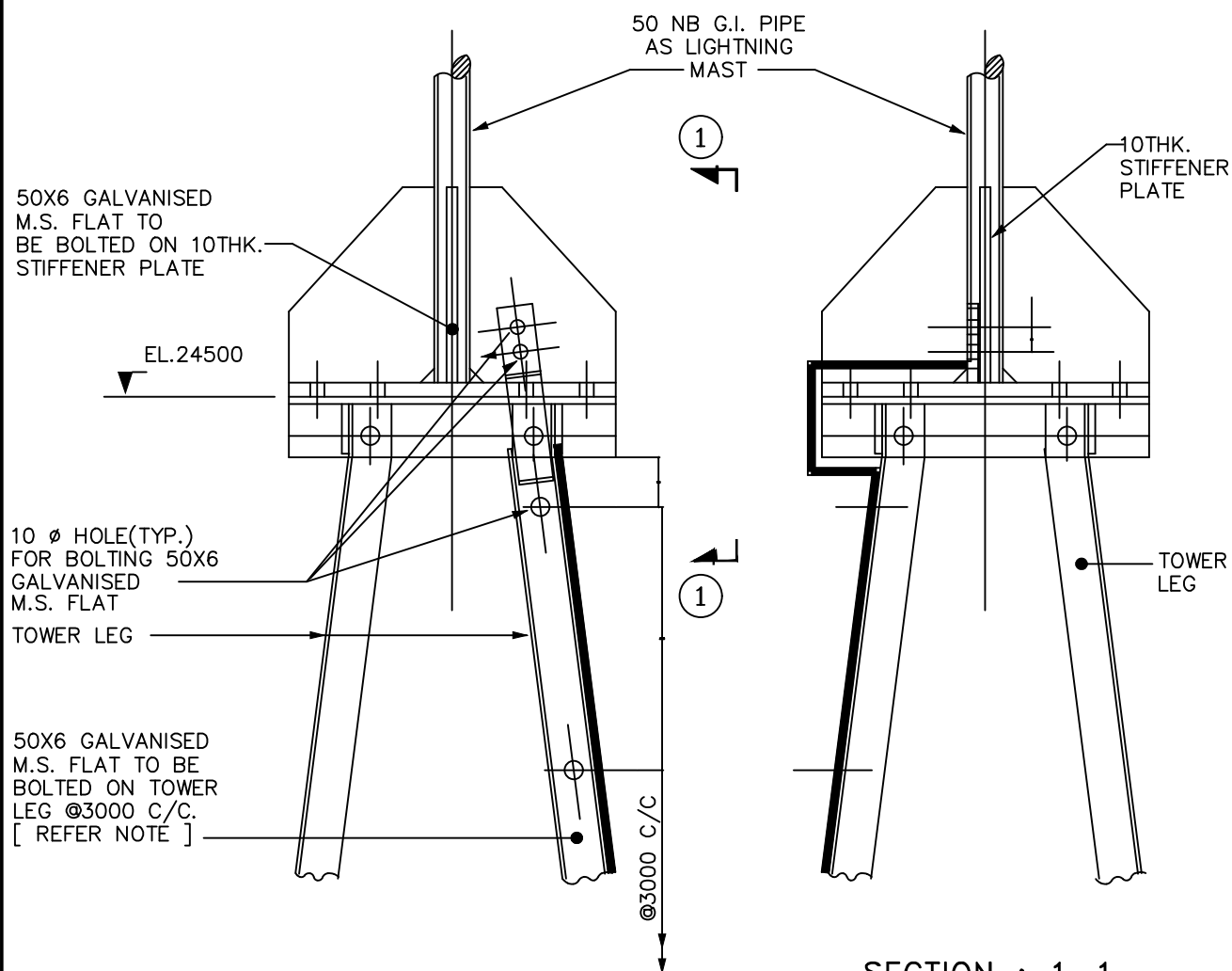
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						 NLC TAMILNADU POWER LIMITED		JOB NO. 18A09	
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN		SCALE : NTS	
APPVD.	REVWD.	CHKD.	REV.	DATE				DWG. NO. 18A09-DWG-E-1000 SHT. 09 OF 12	
								REV. -	



STRINGING ARRANGEMENT & GROUNDING OF G.I. SHIELD WIRE

FOR TENDER PURPOSE ONLY

LIGHTNING PROTECTION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-1000	REV. -
DS	SM	BG	-	12.02.19	SHT. 10 OF 12	
APPVD.	REVWD.	CHKD.	REV.	DATE		

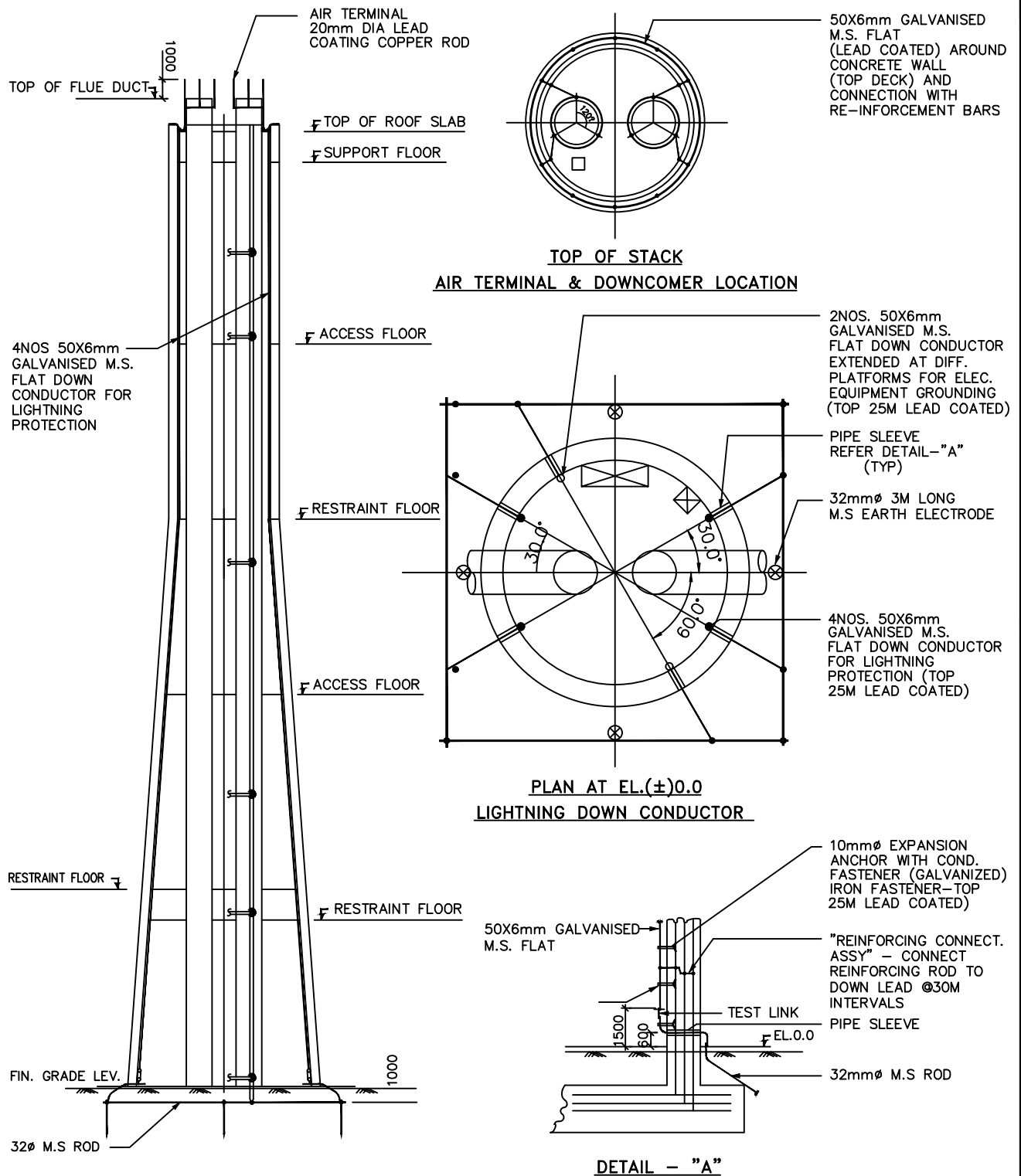


GROUNDING OF SUB-STATION LIGHTNING MAST

NOTE: THESE FLATS SHALL SERVE AS GROUND CONDUCTOR
DOWNCOMER AND SHALL BE CONNECTED TO
SUBSTATION GROUND GRID

FOR TENDER PURPOSE ONLY

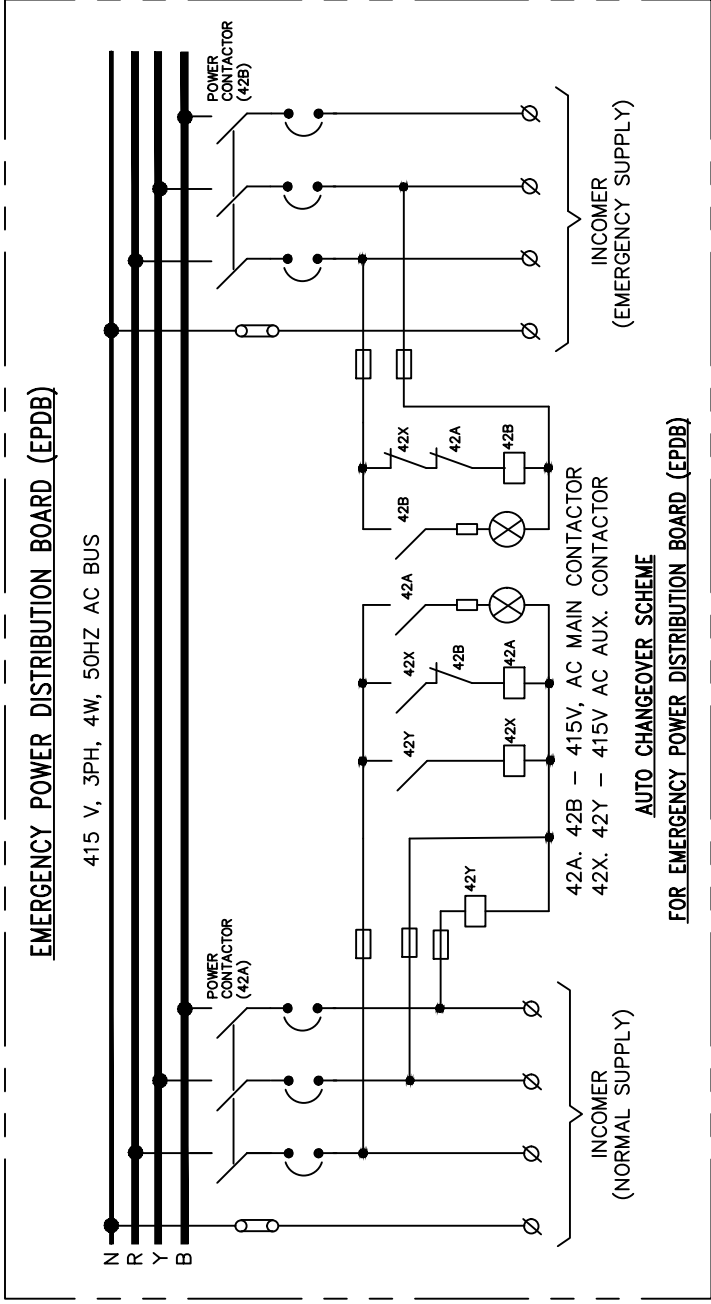
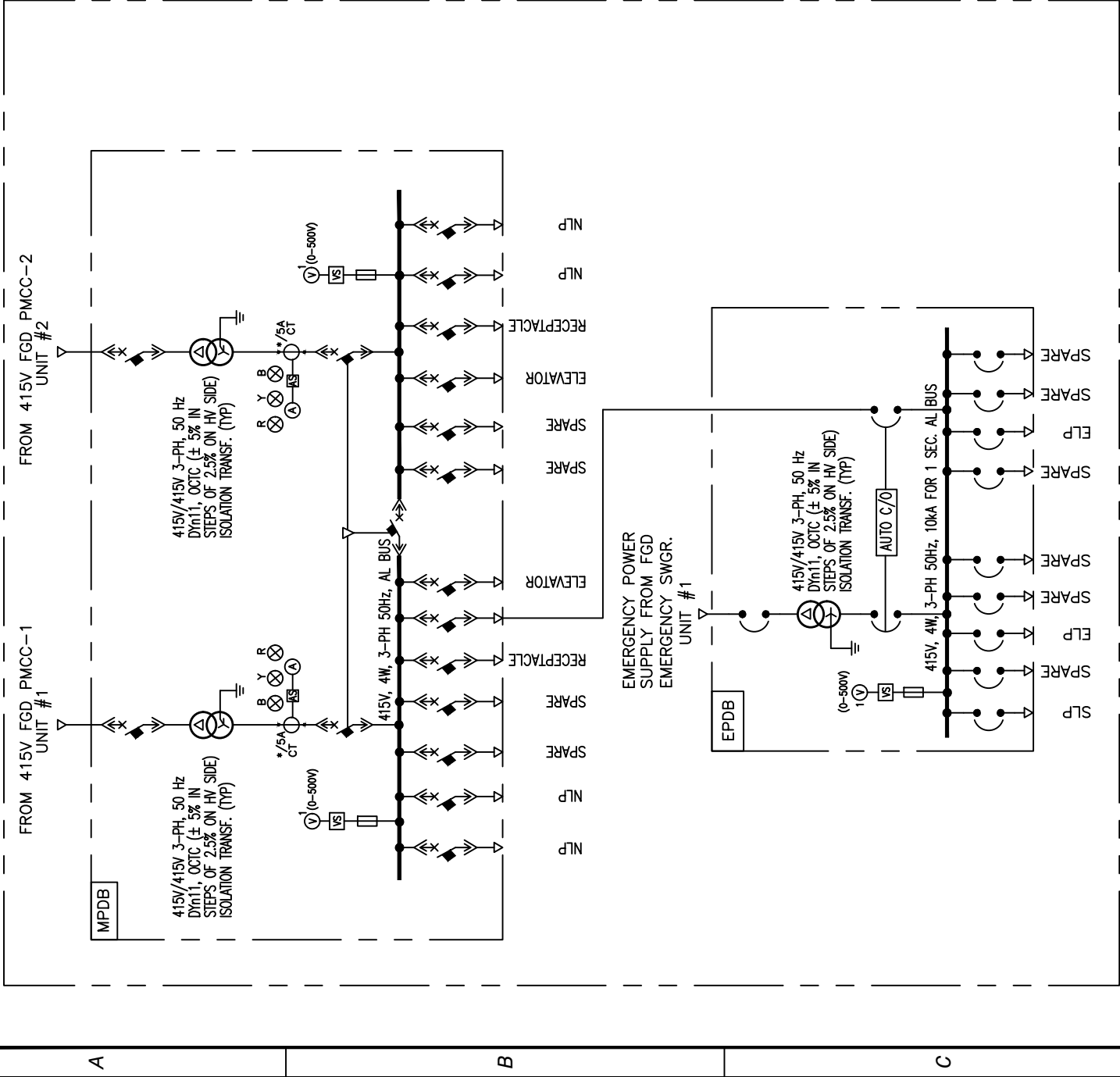
						LIGHTNING PROTECTION NOTES & DETAILS		 DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
						 NLC TAMILNADU POWER LIMITED			
DS	SM	BG	-	12.02.19		2X500MW THERMAL POWER PLANT AT TUTICORIN	JOB NO. 18A09		SCALE : NTS
APPVD.	REVWD.	CHKD.	REV.	DATE			DWG. NO. 18A09-DWG-E-1000 SHT. 11 OF 12		REV. -



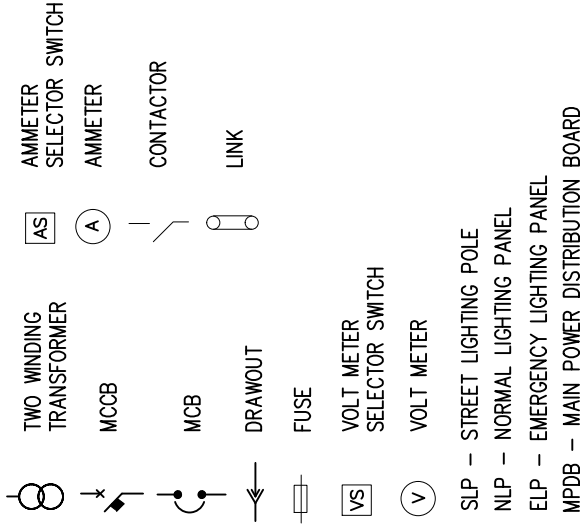
**LIGHTNING PROTECTION
ARRANGEMENT OF RCC STACK**

FOR TENDER PURPOSE ONLY

LIGHTNING PROTECTION NOTES & DETAILS					DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS	
NLC TAMILNADU POWER LIMITED					JOB NO. 18A09	SCALE : NTS
2X500MW THERMAL POWER PLANT AT TUTICORIN					DWG. NO. 18A09-DWG-E-1000	REV. -
DS	SM	BG	-	12.02.19	SHT. 12 OF 12	
APPVD.	REVWD.	CHKD.	REV.	DATE		



LEGENDS :



OWNER: NLC TAMILNADU POWER LIMITED

PROJECT: 2x500MW THERMAL POWER PLANT AT TUTICORIN

TITLE: SINGLE LINE DIAGRAM CHIMNEY POWER DISTRIBUTION

DEVELOPMENT CONSULTANTS PVT LTD. CONSULTING ENGINEERS KOLKATA-MUMBAI-CHENNAI-NEW DELHI

PREPARED	BG	JOB NO.	18A09		REV 0
CHECKED	SM	SCALE	1:1		
APPROVED	DS	DATE	12.02.2019		
DWG. NO.18A09-CHM-DWG-E-0002				1 SHEET OF 1	

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY	12.02.19	SM
TENDER PURPOSE ONLY		
FOR APPROVAL		
FOR CONSTRUCTION		
PROCESS		
MECHANICAL		
CIVIL & STRUCTURAL		
ARCHITECTURAL		
INSTRUMENTATION		
ELECTRICAL		
OTHERS		

REVIEWED	DATE	REV	PREPD	CHKD
PRELIMINARY	12.02.19	0	BG	SM
NATURE OF REVISION & DESCRIPTION				
APPVD	DATE	REV	PREPD	CHKD
DS	12.02.19	0	BG	SM
SM				
ARCH				
C&S				
MECH				
PROCESS				

REPLY TO TECHNICAL QUERIES:**1. M/s. Gammon Engineers and Contractors Pvt. Ltd (GECPL)**

NLCIL Sl. No.	Bidder Sl. No.	Ref. Clause of Tender Document	Existing Provision	Bidders Query	NLCIL/DCPL Reply
60.	Lot 1. Sl. No. 15.	Vol II-B, Section I, Part B, Subsection I, Clause 1.01.0	The steel flues shall be vertically supported at top & at intermediate levels (minimum four platforms) and horizontally restrained on steel platform at intervals satisfying all functional requirements.	As per this clause it is required to support flues at top and at intermediate four platform levels. Whereas tender drawing number 18A09-DWG-C-0001 shows support floor at top one level only. Please clarify is it mandatory to support flue at five level or support can be taken only from one level.	Both tender drawings and Tender specification are conveying the same. Bidder is requested to follow Tender Specification.
61.	16.	Vol II-B, Section I, Part B, Subsection I, Clause 1.02.00	Volume of Gas (at NTP 0 degree C and 1.013 bar): 734.791 Nm ³ /sec	Unit given for volume of gas shall be m ³ /sec instead Nm ³ /sec. Please clarify	Unit given for volume of gas shall be Nm ³ /sec as specified.
62.	17.	Vol II-B, Section I, Part B, Subsection I, Clause 1.02.00	Inlet-duct Center line elevation: During Detail Duct opening Dimensions: Engg. Stage	Inlet duct center line elevation and duct opening dimensions required shall be provided by client. As these are key inputs to finalize bottom diameter of chimney shell. Please provide the details.	As specified, these details will be provided during detail engineering stage after receipt and finalisation of inputs from FGD contractor.
63.	18.	Vol II-B, Section I, Part B, Subsection I, Clause 1.06.00	The Insulation shall consist of 6 layers of insulation material (resin bonded rock wool) each of a minimum thickness of 25 mm and all joints shall be staggered.	Six layer insulation requirement is throughout the height of flue or it is to be provided only for exposed portion above roof level. Please clarify.	The insulation (resin bonded rock wool) is to be provided for the flue above roof level only. Refer Vol-II-B, Section-I, Part-B, Sub Section-I, Clause 1.06.00 (vii)
64.	19.	Vol II-B, Section I, Part B, Subsection I, Clause 1.06.00.ii	Wet Chimney Condensate Collection System: To avoid the carryover of the condensate/acidic dews/water droplets/gypsum coming out of the wet chimney a condensate collection system shall be provided. Design of the condensate system should be	We presume, Wet Chimney Condensate Collection System is not in our scope of work. If it is our scope of works, please provide us the details of system. Please confirm.	It is under bidder's scope as per Tender specification and it is the responsibility of the successful bidder to provide the design and details of the system to NLCIL/NTPL/Consultant

NLCIL Sl. No.	Bidder Sl. No.	Ref. Clause of Tender Document	Existing Provision	Bidders Query	NLCIL/DCPL Reply
			such that the liquid condensate film near the exit of the stack is collected in the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the nearby area.		for approval. Refer Cl. 1.06.00 (vi) of Vol-II & Sec 1 Part B/Sub Sect. 1.
65.	LOT 2 Sl. No. 1	Vol. I-B, Draft Contract, Section 2, Scope of Supply and Services, Cl. 2.6, Page no. 20 of 158 & Vol. IIA, Section 1, Lead Specification, Cl. 7.2.0, Page 6 of 10	Cl. 2.6 Construction Power The Contractor shall be provided with construction power at 415V for the purpose of the erection construction under the Contract only at one point in the project "Site" free of charge. Cl. 7.2.0 power supply at one (1) point at 11 KV AC $\pm$ 10%, 3 Ph, 50 Hz. $\pm$ 5% near the erection site shall be made available with meter; cost of electricity will be charged at prevailing rate.	There is ambiguity in both the clauses regarding charges for supply of Construction Power. Cl. 2.6 of Vol. I-B states Free Supply of electricity whereas Cl. 7.2.0 of Vol. II-A states electricity will be charged at prevailing rate. Please clarify.	It is clarified that the construction power supply will be provided at 415V, free of charge, as per Cl. 2.6 of Vol. IB/ Section-2 and for "Construction Power supply" this clause of Vol-IB supersedes Cl.7.2.0 of Vol-IIA / Sec-I
66.	2.	Vol. II-B, Section 1, Part B, Sub Section 1, Cl. 3.00.00, Page 12 of 28	Ordinary Portland cement namely Grade 43 conforming to IS: 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner.	We presume, we have to use OPC 43 grade cement for entire work of RCC Chimney covered under scope of works. Please confirm.	Bidders understanding is in line with Tender Specification. However, OPC 43 grade cement shall be used not only for RCC Chimney, but also for the entire scope of work as detailed in the bid document.
67.	3.	---	----	Please clarify us whether we can use Fly ash and or GGBS in concrete for all RCC works of Chimney works.	Not acceptable. Tender Condition prevails. Refer the reply given in Sl. No. 66 above.

2. Name of BHEL Unit: PEM-CIVIL

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
68.	Lot 1. Sl. No.1	Volume: II-B Section: I; Part B; Sub Section: I	1.07.00 / 10 of 28	The material of gutter including drain and base plates shall be made of suitable alloy steel to withstand design operating environment.	Please provide the material specification and properties.	Tender condition prevails. Suitable alloy steel to withstand design operating environment as per the recommendations of the Wet Stack Study report shall be used by the successful bidder.
69.	2	Volume: II-B Section: I; Part B; Sub Section: I	1.01.00 / 3 of 28	Wind tunnel study has to be done in any one of the following approved labs – SERC-Chennai, IISc-Bangalore and IIT-Kanpur and the study report shall be got approved by the owner / Consultant.	Bidder proposes that wind tunnel study has to be conducted at a reputed institution approved by bidder.	Tender Condition prevails.
70.	3	Volume: II-B Section: I; Part B; Sub Section: I	6.01.00 (7) / 17 of 28	The maximum width of opening shall be limited to an angle of not more than 30° subtended at the center of the concrete shell. The total plan area of the openings at a particular section shall not be more than 15% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening.	These opening criteria are not in line with the IS:4998 (latest). Bidder suggests to follow the opening criteria as per IS:4998 only. Kindly confirm.	Not acceptable. Tender condition prevails.
71.	4	Volume: II-B	6.01.00 (9) /	Staircase and elevator	Staircase and elevator shall be	Tender condition prevails. However,

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
		Section: I; Part B; Sub Section: I	17 of 28	enclosures shall be provided keeping provision for a rack and pinion type electrically operated elevator.	provided separately supported on chimney shell.	this will be decided during Detailed Engineering based on the profile of the chimney without any commitment & additional cost on/ to the purchaser.
72.	5	Volume: II-B Section: I; Part B; Sub Section: I	6.02.01(1) / 17 of 28	Top 10m length (below roof) or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. Above the roof also, the liner is of AISI:316L/BS:1449 and the height of the flue shall be as per the design requirement Acid Resistant Borosilicate brick lining shall be provided at inside face of the flue.	Bidder proposes to provide length equal to flue diameter from top, using material confirming to AISI:316L or BS:1449.	Not acceptable. Tender condition prevails. Borosilicate lining has to be provided on the inside surface of the flue can from the breaching point and up to the end of flue can.
					Bidder also understands that borosilicate glass block lining has to be provided on inside surface of flue made with material confirming to AISI:316L or BS:1449. Kindly confirm.	Bidder's understanding is in line with Tender specification.
73.	6	Volume: II-B Section: I; Part B; Sub Section: I	6.02.03 / 20 of 28	The liner hood shall be fabricated from 6 mm thick stainless steel sheets of grade 316 L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding.	Bidder understands that inside surface of flue projecting above the roof has also to be lined with borosilicate. Hence, additional insulation packing outside flue is not required. Kindly confirm.	Not acceptable. Tender condition prevails.
74.	7	Volume: II-B Section: I; Part B; Sub Section: I	6.04.00 / 22 of 28	Annular raft with hollow inside is not permitted.	Bidder proposes to allow annular raft i.e. raft with central hollow also. Kindly confirm.	Not acceptable. Tender condition prevails.
75.	8	Volume: II-B	6.05.00 /	Outer platforms shall be of	Outer chimney platform is	Not acceptable. Tender condition

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
		Section: I; Part B; Sub Section: I	22 of 28	RCC. It shall be provided as per Directorate of Air Routes & Aerodromes (DARA) Circular for locating Aviation Warning Lights and for other maintenance purposes. The platforms shall be equally spaced at a spacing of 40 m (maximum). Additional platforms for sampling ports, access doors, clean out doors etc. shall have to be provided as per requirements.	obsolete nowadays. Bidder proposes to provide openings in shell to accommodate AWL as per DARA requirement. Kindly confirm.	prevails.
76.	9	Volume: II-B Section: I; Part B; Sub Section: I	6.10.00 / 24 of 28	Staircase with handrails for chimney will be supported from top of chimney raft & from all internal platforms and not with chimney shell.....	Bidder proposes that staircase and elevator shall be provided separately supported on chimney shell and width of staircase shall be 800mm. Kindly confirm.	Tender condition prevails. However, 'support on Chimney shell' will be decided during Detailed Engineering based on the profile of the chimney without any commitment & additional cost on / to the purchaser. Width of staircase shall be as per Cl.6.10.00 / Vol-II B / Sec-I, Part-B, Sub Sec-I / Page 24 of 28. The request is not acceptable.
77.	10	Volume: II-B Section: I; Part B; Sub Section: I	7.00.00 / 27 of 28	Wind Tunnel Test for the RCC Stack is to be carried out.	Bidder understand that wind tunnel test has to be carried out for proposed new RCC chimney only. Additionally, bidder understand that no design check/ validation/ wind tunnel test of existing chimney/NDCT or any other structure is in the scope of	Tender condition prevails. Wind tunnel test shall be carried out by the successful bidder for the proposed wet RCC chimney envisaged considering all other nearby high rise structures located in the close vicinity of the proposed chimney.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
					bidder. Kindly confirm.	
78.	11	Volume: II-B Section: I; Part B; Sub Section: I	1.06.00 (VII) / 6 of 28	The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183.	Bidder understands that inside surface of flue has to be lined with borosilicate. Hence, additional insulation outside flue is not required. Kindly confirm.	Tender condition prevails. As per 1.06.00 i) & vii) Vol-IIB . Sec-1, Part-B, Sub Sec-I, insulation shall be provided for the external surface of chimney flue liner projecting over the chimney roof.
79.	12	Volume: I-B Section: 2	2.1/page 14 of 158	h) Peripheral Roads / Paving (as required) along with Street Lighting.	Please confirm whether any road is to be constructed in proposed Chimney area.	The same will be furnished to the successful bidder during detailed Engineering stage.
		Volume: II-A Section: 1	4.01.00/page 5 of 10	Peripheral Roads / Paving (as required) along with Street Lighting.	If yes, then please provide the peripheral road layout.	
80.	13	Volume: II-B Section: I; Part A; Sub Section: I	-----	Guideline for Geotechnical Investigation	This is the general guideline for Geotechnical Investigation covering all general tests in soil and rock. All tests mentioned in the specification are technically not required for construction of RCC Chimney. Hence the following Geotechnical Investigation shall only be conducted: 1. 2 no. Bore holes up to 20 m depth below ground level irrespective of soil/rock strata encountered. 2. Laboratory tests on soil and rock samples collected from 2 bore holes 3. Chemical analysis of water	Tender condition prevails.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
					(2 nos.) and sub soil samples 2 no. ERT tests 1 no. cross hole shear wave test 1 no. Field CBR test and one laboratory CBR test No other test shall be conducted. Please confirm.	
81.	14	Volume: II-B Section: I; Part C; Sub Section: I Specific Design Requirements [Civil]	2.00.00/Page 1 of 19	Detail soil investigation, as required, to be carried out for foundation design of various facilities. Soil characteristics and parameters to be adopted in final design, the successful bidder is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required.	During detailed Geotechnical Investigation, following Geotechnical Investigation shall only be conducted: 2 no. Bore holes up to 20 m depth below ground level irrespective of soil/rock strata encountered. - Laboratory tests on soil and rock samples collected from 2 bore holes - Chemical analysis of water (2 nos.) and sub soil samples 2 no. ERT tests 1 no. Cross hole shear wave test 1 no. Field CBR test and one laboratory CBR test No other test shall be conducted. Please confirm.	Tender condition prevails.
82.	15	Volume: II-B	2.00.00/Page 1	The type, size, depth of the	The type, size, depth of the	Not acceptable. Tender condition

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
		Section: I; Part C; Sub Section: I	of 19	foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.	foundation (open foundation or pile foundation) shall be as per approved Geotechnical Investigation Report during contract stage. Please confirm.	prevails.
83.	16	Volume: II-B Section: I; Part B; Sub Section: I General Specification & Design Criteria of Chimney – Civil & Structural Works	6.04.00/page 21 of 28	Foundation Only PILE foundation shall be provided. The bidder shall use the bore log data of Owner's Existing Soil Investigation Report for reference purpose.....The design, size, depth of the foundation shall be based on the approved soil investigation report of the successful Bidder/Owner's soil investigation report whichever is conservative.	The foundation system (Open foundation or pile foundation) shall be as per approved Geotechnical Investigation Report during contract stage. Please confirm.	Not acceptable. Tender condition prevails.
84.	17	Volume: I-B Section: 2	2.1/page 13 of 158	g) Electrical-cum-C&I building / Analyzer shelter to accommodate extractive type analyzer Panels, Data loggers / PC, DB and other necessary accessories.....	Please furnish the size (length, width and height) and finishing schedule of Electrical-cum-C&I building/Analyzer shelter. Electrical-cum-C&I building / Analyzer shelter will be rested on open foundation. Please confirm.	Not acceptable. Tender condition prevails.
85.	18	Volume: II-B Section: I; Part A; Sub Section: V	3.02.00/page 7 of 22	The piles will be bored cast-in-situ cylindrical type RCC piles of 450 mm &/or 550 mm &/or 750 mm &/or 1000 mm dia terminated within	Bored cast-in-situ RCC pile of 600 mm dia shall be used. Please confirm.	Tender condition prevails. However, this will be decided during Detailed Engineering stage.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
				underlying sand stone layer with a rock- socket length not less than 3D		
86.	19	Volume: II-B Section: I; Part A; Sub Section: V	3.02.00/page 7&8 of 22	C) Lateral Capacity The Lateral capacity of single pile, at this site, will be considered as the minimum of the following: - i. 5 % of their respective compressive capacity of pile. Lateral pile capacity assessed by the successful contractor by initial Pile Load Test	Lateral capacity of pile shall be as per approved Geotechnical Investigation Report during contract stage. Lateral capacity of pile shall not be restricted to 5% of their respective compressive capacity. Please confirm.	Not acceptable. Tender condition prevails
87.	20	Volume: II-B Section: I; Part A; Sub Section: I	3.00.00/page 4 of 22	Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The successful bidder shall use his own materials for this and the scope shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the owner in such condition as to enable future observation of ground water possible.	This activity need not to be required after taking water table during investigation. Please exclude the same.	Noted.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
88.	21	Volume: II-B Section: I; Part A; Sub Section: I	4.02.00/4.03.00 Page 11 of 26	Static Cone Penetration Test Dynamic Cone Penetration Test	These tests cannot be performed in the proposed project site due to hard strata followed by rock and hence the same shall be excluded. Please confirm.	Tender Condition prevails.
89.	22	Volume: II-B Section: I; Part A; Sub Sect.: I	5.02.01 & 5.02.02/page 12, 13 of 26	Pump - in Test Pump - Out Test	For chimney foundation, these tests are not relevant. Please exclude the same.	Tender Condition prevails.
90.	23	Volume: II-B Section: I; Part A; Sub Sec: I	6.02.02/page 14 of 26	Direct Load Tests on Soils	For chimney foundation, this test is not relevant. Please exclude the same.	Tender Condition prevails.
91.	24	Volume: II-B Section: I; Part A; Sub Section: I	6.03/page 15 of 26	Vane Shear Tests	This test is conducted on soft clay. In proposed project site, soft clay is not encountered. Hence the same is not possible. Please exclude the same.	Tender Condition prevails.
92.	25	Volume: II-B Section: I; Part A; Sub Sec.: I	6.05/page 17 of 26	In-situ Block Shear / Wedge Shear Test	This test is not relevant for chimney foundation. Please exclude the same	Tender Condition prevails.
93.	26	Volume: II-B Section: I; Part A; Sub Sec.: I	7.00.00/page 18 of 26	TEST FOR DYNAMIC PROPERTIES	For evaluation of Dynamic properties, only cross hole shear test shall be performed. Block vibration test and cyclic plate load test shall not be conducted. Please confirm.	Tender Condition prevails.
94.	27	Volume: II-B Section: I; Part A; Sub Sect: V	3.05.00/page 9 of 22	Boring Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools...	Boring for all piling shall be carried out by temporary casing. Please confirm.	Tender Condition prevails.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply																		
95.	28	Volume: II-B Section: I; Part A; Sub Sec.: V	4.07.00/ page 21 of 22	Lateral Dynamic Load Test on Piles	In case of chimney foundation, this test is not required and the same shall not be conducted. Please confirm.	Tender Condition prevails.																		
96.	29	-----	-----	General	Please furnish the finished ground level (FGL) of the proposed Chimney area.	FGL of the proposed area of Wet Chimney is +2.40m +/-0.00 corresponds to finished floor level of plant which is 2.90 m from chart datum and chart datum is – 0.64m from mean sea level (MSL)																		
97.	30	-----	-----	General	Please furnish the Topographical survey drawing of the proposed Chimney area.	Since it is running plant, the necessity of topographical survey drawing may not arise.																		
98.	31	-----	-----	General	Please furnish the peripheral road layout around the proposed Chimney area.	The same will be furnished to the successful bidder during Detailed Engineering stage.																		
99.	Lot 2 Sl. No. 1	Volume: II-B Section: I; Part B; Sub Sect: I General Specification & Design Criteria of Chimney – Civil & Structural Works	Page 3 of 28 Clause no. 1.02.00	General parameters of the chimney	1. Following parameters may be arranged / furnished by the customer/consultant a) Flue gas composition b) Density at operating temperature c) Actual volumetric flow 2. In case of wet stacks, flue gas pressure at chimney entry level is comes in the range of (-)20mmWC to (-)40mmWC and it is required to be considered in ID fan /booster fan selection. Hence, flue gas pressure at Chimney entry level cannot be considered as NIL. Customer / consultant to review and update	1. The following are the parameters: a) Flue gas composition @ chimney inlet: <table><tr><td>H2O</td><td>Vol %</td><td>12.54</td></tr><tr><td>SO2</td><td>Vol %</td><td>0.01</td></tr><tr><td>SO3</td><td>Vol %</td><td>0</td></tr><tr><td>CO2</td><td>Vol %</td><td>14.33</td></tr><tr><td>O2</td><td>Vol %</td><td>3.34</td></tr><tr><td>N2</td><td>Vol %</td><td>69.78</td></tr></table> b) Flue gas density -1.102 kg/m3; Operating Temperature -50 °C c) Flue gas flow -2758744 m3/hr 2. Noted. The additional pressure drop due to wet chimney to get excess draft is already considered in Booster fan design.	H2O	Vol %	12.54	SO2	Vol %	0.01	SO3	Vol %	0	CO2	Vol %	14.33	O2	Vol %	3.34	N2	Vol %	69.78
H2O	Vol %	12.54																						
SO2	Vol %	0.01																						
SO3	Vol %	0																						
CO2	Vol %	14.33																						
O2	Vol %	3.34																						
N2	Vol %	69.78																						

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
					the same.	
100.	Lot 3 Sl. No. 1	NIT	1.2 (b), page 1 of 6	The MS flue can shall be of corrosion resistant steel type COR-TEN B of minimum 10mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using SS material confirming to AISI : 316L or BS: 1449.	Bidder request to also consider “ASTM A588 GRADE-B” in place of COR-TEN B material for MS flue can.	Tender Condition prevails.
101.	2.	Section 1 Part B of Volume II B	1.01.1 (Sub-section – I, page no. 2 of 28, 2 nd paragraph)	 and erection of associated steel work and other chemicals on the completed structures.....	Bidder understands that other chemical means painting of structural surface.	Tender condition prevails.
102.	3.	Section 1 Part B of Volume II B	3.00.00 (Sub-section – I, page no. 12 of 28, 2 nd paragraph)	Ordinary Portland cement namely OPC 43 conforming to IS: 8112 (Latest revision) shall be used for construction.....	IS: 8112 has been withdrawn and replaced by IS: 269-2015.	Noted. IS: 269-2015 shall be followed in place of IS: 8112 wherever specified.
103.	4.	Section 1 part B of Volume II B	3.00.00 (Sub-section – I, page no. 12 of 28, 4 th paragraph)	 plates for steel flue shall be CORTEN B steel conforming to IS 2062 having yield stress 250 MPa.	COR-TEN B steel does not conform to IS: 2062. It conforms to ASTM A588 GRADE-B. Hence, equivalent material conforming to ASTM A588 GRADE-B shall be permitted for steel flue of chimney.	Tender Condition prevails.
104.	5.	Section 1 part B of Volume II B	3.01.00 (Sub-section – II, page no. 7 of 15, 1 st paragraph)	At least three weeks before commencing any concreting in the work the bidder shall make trial mixes using samples of coarse aggregate, sand,	Please refer point no. 6 for query.	Tender Condition prevails.

NLCIL Sl. No.	Bidder Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
				water and cement,.....		
105.	6.	Section II of Volume II A	1.3.0 (page no. 2 of 11)	Implementation schedule..... a. Test piles and load test 2 months from zero date	Requirement prior to submission of report of test piles are as follows: a. Approval of source for materials and approval of design mix – which will take minimum 6 weeks from zero date. b. Trial mix at site – which will take minimum 4 months after approval of design mix – to obtain the 28 days strength of trial mix. c. Load test on pile can be conducted only after completion of 28 days age of pile. Hence, minimum time required for completion of test pile and load test is 14 weeks. Bidder requests to accordingly modify the schedule.	Not acceptable. Tender Condition prevails.
106.	7.	Section II of Volume II A : Sub – section VI	3.01.00 (page no. 11 of 23)	Fabrication may be either shop fabricated of site fabricated.	May please be corrected as “Fabrication may either shop fabricated or site fabricated.”	Noted.
107.	8.	Section III of Volume II A	Annexure – 1, (page no. 12 of 16)	Acceptance criteria for sub- contractor: - ii) For civil & structural works: All civil & structural works related to chimney, shall	Bidder requests to allow engagement of sub- contractor for civil & structural works.	Not acceptable. Tender Condition prevails.

NLCIL Sl. No.	Bidder Sl. No.	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	NLCIL/DCPL Reply
				be carried out by the successful bidder as per QR requirements by which the successful bidder got qualified.		

3. M/s. Bygging India Limited.

Sl. No.	Bidder Sl. No.	Ref. Clause of Tender Document	Existing Provision	Bygging Query	NLCIL/ DCPL Reply
108.	32	Volume-II B, Section –1 Part – A, Sub Section: IV Cement Concrete Clause No. 2.05.02 (iii)	The Crushed stone sand in general shall not be used for the following structures/facilities: - a) Structures constructed using slip form technology b) All internal & external plastering works. The structures where the slip form construction is envisaged the M-sand or Crushed stone sand may be used for casting its foundations only as they are not constructed using slip form Technology.	Crushed stone sand will be allowed for chimney construction as being allowed at the other places	Tender Condition prevails. Bidder is requested to follow Tender Condition.
109.	33	Volume-II B, Section –1 Part – A, Sub Section: VI Fabrication of Structural Steel work Clause No. 3.00 Workmanship	Fabrication: Fabrication may be either shop fabricated of Site fabricated.	It may be noted as: Fabrication may be either shop fabricated or Site fabricated.	Noted.
110.	34	Volume-II B, Section –1 Part – B, Sub Section: I General Specification & Design Criteria of Chimney Clause No.- 1.06 (iv) Workmanship	Liquid collectors shall be designed and developed experimentally using a physical model	Please allow use of FRP	Tender condition prevails. Bidder is requested to follow Tender Condition. Suitable alloy steel as per Cl. No. 1.07.00, Sec 1, Part B, Sub Sec 1, page 10 of 28, Vol II B only shall be used

Sl. No.	Bidder Sl. No.	Ref. Clause of Tender Document	Existing Provision	Bygging Query	NLCI L/ DCPL Reply
111.		Volume-II B, Section – 1 Part – B, Sub Section: I General Specification & Design Criteria of Chimney Clause No.- 1.06 (v) Workmanship	A common Nickel based alloy material storage/neutralizing tank for both the units of storage capacity of as per mechanical requirement of condensate from both the flues shall be provided complete with neutralizing chemicals dosing, mixing and preparation system. The neutralized condensate shall be pumped to common drain system by pumps as per mechanical requirement, complete with valves, piping and fittings, level control and monitoring etc. All the equipment, piping and Fittings in contact with the condensate shall be of suitable material for the operating duty. The condensate collection system in this package includes condensate from FGD outlet up to flue can top.	FGD outlet up to flue can top for Chimney only	Bidder's query is not clear. However, bidder to note that Tender condition prevails. Bidder is requested to follow Tender condition.
112.		Volume-II B, Section –1 Part – B, Sub Section: I General Specification & Design Criteria of Chimney Clause No.- 6.04 Foundation	Only PILE foundation shall be provided.	Type of the Foundation will be based on the design	Tender condition prevails. Only Pile foundation shall be provided. Bidder is requested to follow Tender Condition.
113.		Volume-II B Section – 1 Part – B, Sub Section: I General Specification & Design Criteria of Chimney Clause No.- 6.04 Foundation	The pile cap may be treated as raft and annular raft with hollow inside is not permitted. Pile cap diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12.	Please allow Annular raft if design permits	Not acceptable. Tender condition prevails. Bidder is requested to follow Tender Condition.
114.	33	Volume-II B, Section– 1 Part – B, Sub Section: I General Specification & Design Criteria of Chimney Clause No.- 6.05 Outer Platforms	Outer platforms shall be of RCC. It shall be provided as per Directorate of Air Routes & Aerodromes (DARA) Circular for locating Aviation Warning Lights and for other maintenance purposes. The platforms shall be equally spaced at a spacing of 40 m (maximum). Additional platforms for	The external platforms are not required as maintenance of aviation light can be done from inside. This is regular practice adopted by NTPC & other plant owners	Tender condition prevails. Bidder is requested to follow Tender Condition.

Sl. No.	Bidder Sl. No.	Ref. Clause of Tender Document	Existing Provision	Bygging Query	NLCI L/ DCPL Reply
			sampling ports, access doors, clean out doors etc. shall have to be provided as per requirements. Total nos. of external platforms will be 4 nos.(minimum).		

4. M/s. HADEK

NLCIL SI No.	Bidder SI. No.	Reference Section/Clause/ Sub Clause	Description /Provision in tender document	Hadek's Query	NLCIL/DCPL reply
115.	1.	Acceptance Criteria for Sub Vendors, Page 11 of 16 Vol. II-A/Section-III Engineering Services	vii) (a) The Firm should be a manufacturer of Borosilicate Lining System or authorised supplier of the manufacturer (OEM) and should have supplied, erected/ supervised erection of Borosilicate Block Chimney Lining system for at least one (1) number of RCC chimney of minimum 150 Meters height with steel flue can in a power plant. (b) The above Borosilicate block Chimney Lining system should have completed satisfactory operation for a period of not less than one (1) year as on the original scheduled date of Tender opening. (c) The Bidder should furnish documentary evidence to prove (a) & (b) above by furnishing the following documents: i. Bidder shall furnish the PO copy / supporting documents of at least one (1) executed Contract as mentioned in 'a' above. ii. Corresponding certificate from owner for successful operation of 'borosilicate Glass block lining system' as mentioned in 'b' above indicating date of commissioning.	(1) Is it required for the chimney flue lining system to have a record of successful use under FGD Wet Stack (i.e. low temperature, water saturated, non-reheated) operating conditions? If yes, please indicate how many references and how many years of successful operation must be demonstrated.	Tender Condition prevails and is self explanatory.
				(2) Is it required for the chimney flue lining system to not allow any liquid re-entrainment at 18.3 m/s, or is it acceptable to allow minimal, but not significant re-entrainment of liquid condensate into the flue gas stream?	Tender Condition prevails and is self explanatory. Refer Cl. 1.07.00/Vol-IIB Sec-I, Part-B, Sub Sec-I/ Page 7 of 28.
				(3) Are there any possible operating conditions where the flue gas velocity will be higher than 18.3 m/s? If yes, (a) please indicate how high the velocity would be and (b) if it is acceptable for re-entrainment to occur under such operating conditions?	Bidder's query doesn't have relevance to the technical specification of the bid document.

NLCIL SI No.	Bidder SI. No.	Reference Section/Clause/ Sub Clause	Description /Provision in tender document	Hadek's Query	NLCIL/DCPL reply
116.	2.	Acceptance Criteria for Sub Vendors, Page 11 of 16 Vol. II-A/Section-III Engineering Services	NOTE: During the application of the Borosilicate Lining system, the sub vendor who is supplying the Borosilicate Lining system shall also supply sufficient number of skilled supervisors to assist the Application of the Borosilicate Lining system by the successful bidder. A separate QA plan towards this shall be furnished before starting of the works by the sub vendor for the approval of the owner.	(4) Is it acceptable for the lining system supplier to make incidental checks during the lining installation works, or is full time technical supervision of the installation works required? (5) In a previous (international) tender related to this project, NLC required that technical supervisors deputed by the lining system supplier should have a minimum 5 year experience in the use of the subject lining system. Is this requirement still valid for the current tender?	Tender Specification is self explanatory & very clear. Tender Condition prevails and is self explanatory. Refer Cl. 1.07.00 / Vol-II B Sec-I, Part-B, Sub Sec-I / Page 9 & 10 of 28.


 18.07.2022
 For GENERAL MANAGER / CONTRACTS & IE

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Mechanical -DEVIATIONS

Bidder: M/s BHEL

Annexure-2.1

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL REPLY	Bidder's Reply	TCM Resolution
	Vol/Chapter/Clause/ Page	TS Requirement	Vol/Chapter/Clause/ Page	Deviation (or) Offer Details			
1.	General		Schedule F4 Deviation Schedule To Technical Specification	-	It is noted that the Bidder has not taken any deviation on stack elevator in the offer and the bidder completely complying with bid specification without any deviation. Bidder to confirm.	Shall be discussed during TCM	Bidder confirmed. NLCIL/DCPL Noted Point closed

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
COMMENTS ON WRITE-UP-Mechanical	
Bidder: M/s BHEL	Annexure 2.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-II	-			Bidder has not submitted any technical write-up of stack elevator. Bidder to confirm that the offer completely complying with the bid specification requirement.	Shall be discussed during TCM.	Bidder informed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering. However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted Point closed

M/s NLCIL



M/s DCPL (Consultant)



M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

COMMENTS ON WRITE-UP-Mechanical

Bidder: M/s BHEL

Annexure 2.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
2	Vol. -II B; Section-I, Part- B, Subsection-I, Cl.1.06.00-iv	Liquid collectors shall be designed and developed experimentally using a physical model. The model shall begin at the outlet of the absorber mist eliminator(s), including the absorber outlet and ducting, the stack breaching duct and a minimum of three (3) diameters of the stack liner above the top of the stack breaching duct. Physical model shall include any internal devices that may affect the gas flow, such as structural members, flow controls, and expansion joints. Liquid collectors shall be located where needed in			Bidder to confirm the physical flow model study shall be carried out from absorber outlet to chimney and provide the necessary drain collection equipments and flow control device based on the physical flow model study results from absorber outlet to chimney will be in Bidder		Bidder noted and confirmed. NLCIL/DCPL noted Point closed

M/s NLCIL



M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
COMMENTS ON WRITE-UP-Mechanical	
Bidder: M/s BHEL	Annexure 2.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
		the absorber outlet, the ductwork between the absorber outlet and the chimney liner, in the chimney liner, and in the exit nozzle. These collectors shall collect liquid from surfaces, prevent re-entrainment, and guide the liquid to locations where it can be drained out of the system and prevent the discharge of droplets from the top of the stack that are large enough to drain out to the ground before evaporation. For the model studies, sharing of the necessary			scope		

M/s NLCIL



M/s DCPL (Consultant)



M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
COMMENTS ON WRITE-UP-Mechanical	
Bidder: M/s BHEL	Annexure 2.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
		input and result details with the FGD vendor shall be considered for reiteration of model study and finalizing the ducting and flue can design.					

M/s NLCIL



M/s DCPL (Consultant)



M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Comments on SPARES - Mechanical	
Bidder: M/s BHEL	Annexure 2.3

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-II, Annexure-II	Spares	Sl.No.11: Mandatory spares.	Elevator spares	Bidder to confirm to supply the mandatory spares as listed in the Tender Specification and shall furnish item wise price breakup for the same as per Table-3 / Schedule F-1. <i>The line below the list. "The Applicable spares from the above list shall be supplied by M/s BHELPSSR" shall be deleted.</i>	To be discussed in TCM	Refer S.No 2 Annexure 1.1 NLCIL/DCPL noted Point closed

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Comments on SUB-VENDOR LIST - Mechanical

Bidder: M/s BHEL

Annexure 2.4

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II A; Section-III Annexure-1	List of Sub-vendors-Mechanical equipment	Sl.No.13 : List of sub-vendors-Mechanical	Shall be provided during execution.	Bidder to furnish the Sub-Vendor list Stack elevator in editable format before the Techno-commercial meeting.	To be discussed in TCM	During the meeting M/s BHEL was informed to submit the Mechanical sub-vendor list in line with TS requirements on or before 25.01.2021 NLCIL/DCPL informed that the consolidated and categorized list of sub vendors will be

M/s NLCIL

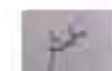
M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Comments on SUB-VENDOR LIST - Mechanical	
Bidder: M/s BHEL	Annexure 2.4

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
							communicated to the bidder separately. M/s BHEL noted and confirmed. NLCIL/DCPL Noted.

M/s NLCIL



M/s DCPL (Consultant)



M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Mechanical - DATA SHEET

Bidder: M/s BHEL

Annexure 2.5

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-II	-	Sl.No.8.1: Technical Data sheet- Mechanical	Shall be submitted after the award of contract during execution. Technical detail depend upon the make of the selected equipment.	Bidder has not submitted the technical data sheet for stack elevator. Bidder to confirm that the offer completely complying with the bid specification requirement.	Shall be discussed during TCM.	Bidder informed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering. However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted Point closed

M/s NLCIL


M/s DCPL (Consultant)

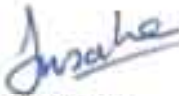

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
COMMENTS ON DRAWINGS - Mechanical	
Bidder: M/s BHEL	Annexure 2.6

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-II	-	Sl.No.10.2: Drawings	Shall be submitted after the award of contract during execution. Technical detail depend upon the make of the selected equipment.	Bidder has not submitted stack elevator drawings along with the offer. Bidder to confirm compliance to the Technical specification and Tender drawings.	Shall be discussed during TCM	Bidder informed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering. However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted Point closed

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

TECHNO COMMERCIAL MEETING Dated: 18.01.2021

Electrical (Annexure-4.1)

DEVIATIONS

Bidder: M/s Bharat Heavy Electrical Limited (BHEL)

Annexure-4.1

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL REPLY	Bidder's Reply	TCM Resolution
	Vol/Chapter/Clause/Page	TS Requirement	Vol/Chapter/Clause/Page	Deviation (or) Offer Details			
1.	General		Schedule F4 : Deviation Schedule To Technical Specification	-	It is noted that the Bidder has not taken any deviation in the offer and the bidder completely complying with bid specification without any deviation. Bidder to confirm.	BHEL confirms compliance to tender conditions read in conjunction with amendments/ resolution to post bid discussions/ subsequent amendments/ approvals.	NLCIL / DCPL Noted Point Closed.

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined BI-flue can arrangement for FGD Plant	
TECHNO COMMERCIAL MEETING Dated: 18.01.2021	
Electrical (Annexure-4.2)	
COMMENTS ON WRITE-UP	
Bidder: M/s BHEL	Annexure 4.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-III	-	Sl.No.10.1: Technical Write-up	Shall be submitted after the award of contract during execution. Technical detail depend upon the make of the selected equipment.	Bidder has not submitted an technical write-up. Bidder to confirm that the offer completely complying with the bid specification requirement.	To be discussed in TCM	M/s BHEL confirmed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering. However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted. Point closed.
2.	Vol-IB, Section-2, Cl. 2.6 (i), page 20 of	Construction Power.	Schedule F5, Construction Power	500 kVA for 21 months.	Construction Power Shall be provided at 415V	To be discussed in TCM	M/s. BHEL ~~Confirms~~ <i>noted</i> ~~compliance with Tender and specification.~~ <i>Confirmed</i>

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
TECHNO COMMERCIAL MEETING Dated: 18.01.2021	
Electrical (Annexure-4.2)	
COMMENTS ON WRITE-UP	
Bidder: M/s BHEL	Annexure 4.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
	158		Requirement		for the purpose of erection construction under the contract at one point. Bidder to confirm compliance.		NLCIL/DCPL Noted. Point Closed.
3.		Quality Assurance Plan	Sl.No.14.0	Quality Assurance Plan	Bidder to submit the detailed quality assurance plan (MQP, Field quality plan, etc.) for each equipment and system separately during post award	To be discussed in TCM	M/s. BHEL confirms to submit the detailed quality assurance plan (MQP, Field quality plan, etc.) for each equipment and system separately during post award engineering for Owner's review and approval.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
TECHNO COMMERCIAL MEETING Dated: 18.01.2021	
Electrical (Annexure-4.2)	
COMMENTS ON WRITE-UP	
Bidder: M/s BHEL	Annexure 4.2

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
					engineering for Owner's review and approval. Bidder to confirm compliance.		NLCIL/DCPL Noted. Point Closed

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

TECHNO COMMERCIAL MEETING Dt: 18.01.2021

Electrical (Annexure-4.3)

Comments on SPARES

Bidder: M/s Bharat Heavy Electrical Limited (BHEL)

Annexure 4.3

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B, Section-II, Annexure-II and Section-III, Annexure-A	Spares	Sl.No.11 : Mandatory spares.	Chimney spares and Elevator spares	Bidder to confirm to supply the mandatory spares as listed in the Tender Specification and shall furnish item wise price breakup for the same as per Table-3 / Schedule F-1. <i>The line below the list. "The Applicable spares from the above list shall be supplied by M/s BHEL PSSR" shall be deleted.</i>	To be discussed in TCM	Refer S No. 2 of Annexure 1 NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined BI-flue can arrangement for FGD Plant	
TECHNO COMMERCIAL MEETING Dated: 18.01.2021	
Electrical (Annexure-4.4)	
Comments on SUB-VENDOR LIST	
Bidder: M/s Bharat Heavy Electrical Limited (BHEL)	Annexure 4.4

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II A, Section-III	List of Sub-vendors-Electrical equipment	Sl.No.13 List of sub-vendors-Electrical	Shall be provided during execution.	Bidder to furnish the Sub-Vendor list for class-I and Class-II electrical items mentioned in the bid specification in editable form before the Techno-commercial meeting. Classification of sub vendors into category-I and category-II shall be intimated by the purchaser.	To be discussed in TCM.	During the meeting M/s BHEL was informed to submit the Electrical sub-vendor list in line with TS requirements on or before 25.01.2021. NLCIL/DCPL informed that the consolidated and categorized list of sub vendors will be communicated to

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
TECHNO COMMERCIAL MEETING Dated: 18.01.2021	
Electrical (Annexure-4.4)	
Comments on SUB-VENDOR LIST	
Bidder: M/s Bharat Heavy Electrical Limited (BHEL)	Annexure 4.4

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
							the bidder separately M/s BHEL noted and confirmed NLCIL/DCPL Noted.

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

TECHNO COMMERCIAL MEETING Dated: 18.01.2021

ELECTRICAL (Annexure-4.5)

Comments on DATA SHEET

Bidder: M/s Bharat Heavy Electrical Limited (BHEL)

Annexure 4.5

S.N α	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specificatio n details	Bid ref.	Bid details			
1	Vol. -II B, Section-III	-	SI.No.8.2 Technical Data sheet-Electrical	Shall be submitted after the award of contract during execution. Technical detail depend upon the make of the selected equipment.	Bidder has not submitted the technical data sheet. Bidder to confirm that the offer completely complying with the bid specification requirement.	Shall be discussed during TCM.	M/s BHEL confirmed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

TECHNO COMMERCIAL MEETING Dated : 18.01.2021

Electrical (Annexure-4.6)

COMMENTS ON DRAWINGS

Bidder: M/s Bharat Heavy Electrical Limited (BHEL)

Annexure 4.6

S.No	TENDER SPECIFICATION REFERENCE		OFFER REFERENCE		NLCIL/DCPL Comments	Bidder's Reply	TCM RESOLUTION
	Vol. / Clause/ Page no	Specification details	Bid ref.	Bid details			
1.	Vol. -II B; Section-III	-	Sl.No.10.2: Drawings	Shall be submitted after the award of contract during execution. Technical detail depend upon the make of the selected equipment.	Bidder has not submitted any Electrical drawings along with the offer. Bidder to confirm compliance to the Technical specification and Tender drawings.	Shall be discussed during TCM.	M/s BHEL confirmed that the details shall be provided during execution of the contract as they shall be firmed after detailed engineering. However, the same shall be meeting the tender conditions/approval of the Purchaser. NLCIL/DCPL Noted. Point closed.

M/s NLCIL



M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.1)

DEVIATION

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.1

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Vol/Clause/ Page No.	Deviation (or) Offer Details			
1.	Volume II-A/ Section-III/Annexure-1(e)	Purchaser may consider However, price advantage if any, arising out of inclusion of new sub vendors will be passed on to the Purchaser.	Sl. No.1 of Schedule-F4 (Deviation Schedule to Technical Specification)	Please delete "However, price advantage if any, arising out of inclusion of new sub vendors will be passed on to the Purchaser."	Not acceptable. Tender condition prevails. M/s. BHEL shall withdraw the deviation taken. M/s BHEL to note and confirm.	To be discussed in TCM	During the meeting, M/s BHEL withdrew the deviation taken and confirmed compliance to Tender specification NLCIL/DCPL noted. Point Closed.
2.	Volume II-A/ Section-II/ Clause No 1.3.0/ Page 2 of 11		Sl. No.2 of Schedule-F4 (Deviation Schedule to Technical Specification)	1.Geo-Technical approved drawings (Minimum 3 months required for investigation and approval of drawings) is required for approval of Test pile drawings. But Geotechnical	Not acceptable. Tender condition prevails. M/s. BHEL shall withdraw the deviation taken. M/s BHEL to note	To be discussed in TCM	During the meeting M/s BHEL withdrew the deviation taken and confirmed compliance to Project duration of 21 months

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.1)

DEVIATION

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.1

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Vol/Clause/ Page No.	Deviation (or) Offer Details			
				investigation is not included in the implementation schedule. 2. Borosilicate lining which is a time consuming and critical major work will take minimum three months to execute. But the same is not included in the implementation schedule. The above two will lead to time and cost overruns.	and confirm.		NLCIL/DCPL noted Point Closed.
3.	General		Sl. No.3 of Schedule-F4 (Deviation	It is understood that multiple brand of Cements can be used	Not acceptable. Tender condition prevails.	To be discussed	During the meeting, NLCIL/ DCPL informed that the

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.1)

DEVIATION

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.1

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Vol/Clause/ Page No.	Deviation (or) Offer Details			
			Schedule to Technical Specification)	for Construction of Chimney Shell.	M/s. BHEL shall withdraw the deviation taken. M/s BHEL to note and confirm.	in TCM	request of M/s BHEL is not acceptable to NLCIL/DCPL Hence, M/s BHEL withdrew the deviation taken and confirmed compliance to Tender specification with Price Implication. NLCIL/DCPL noted. Point Closed.

Note: If any deviation has marked other than F4 schedule, those points will not be considered as the deviation. –TCM Resolution:

During the meeting M/s BHEL noted and confirmed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.2)

WRITE UP

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.2

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Bid Ref.	Bid Details			
1.	-	-	-	Bidder has not furnished Civil & Structural write-up in the Bid document.	Bidder shall confirm that their offer is strictly in line with the Tender Specification Volume-II & Tender drawings for Civil, Architectural & Structural works. M/s BHEL to note & confirm.	BHEL confirms compliance to tender conditions read in conjunction with amendments/ resolution to post bid discussions/ subsequent amendments/ approvals.	Where ever deviations agreed by NLCIL/DCPL in Annexure for Deviation under the respective discipline, alone is accepted as deviation. No other deviation elsewhere in the bid shall be considered. M/s BHEL noted and confirmed. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.2)

WRITE UP

Bidder: M/s Bharat Heavy Electricals Limited, (BHEL)

ANNEXURE 5.2

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Bid Ref.	Bid Details			
2.	Volume-1A/ Schedule F5	Requirements of the Contractor at site	Schedule F5	Bidder has sought land for Site fabrication & construction activities at site put together 10,000 Sq. m.	Bidder to note that sufficient land as per availability shall be provided (inside the plant boundary and/or land outside the plant boundary) to the successful bidder subject to availability of land. M/s BHEL to note and confirm.	To be discussed in TCM	During the meeting NLCIL/DCPL requested to follow Cl.2.7.1 i)/ Vol-1B/ Section-2/ Page 21 of 158 NTPL informed that the land as requested by BHEL will be allotted within the Plant boundary and may be in more than 1 (one) location as per availability. M/s BHEL agreed to follow Tender specification. NLCIL/DCPL noted

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.2)

WRITE UP

Bidder: M/s Bharat Heavy Electricals Limited, (BHEL)

ANNEXURE 5.2

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Bid Ref.	Bid Details			
							Point closed.
3.	Volume-IA/ Schedule F5	Requirements of the Contractor at site	Schedule F5	Bidder has sought the requirement of Construction water at site as 60 cubic meters per day for 21 months.	Bidder to note that sufficient construction water to meet the construction requirements shall be provided by the owner. M/s BHEL to note and confirm.	To be discussed in TCM	During the meeting NLCIL/DCPL informed that 'sufficient construction water to meet the construction requirements shall be provided by the owner as per Tender Specification'. M/s BHEL noted and confirmed. NLCIL/DCPL noted Point closed
4.	Volume-IA/ Schedule	Contractor's Resource	Schedule F6	Bidder has not furnished resource	However, M/s BHEL shall confirm that the	To be discussed	During the meeting M/s BHEL noted and

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.2)

WRITE UP

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.2

Sl. No	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement	Bid Ref.	Bid Details			
	F6	Deployment Schedule		deployment schedule.	MANPOWER requirement is in line with the project time schedule, L1 PERT & depending upon the peak Civil activities at site. M/s. BHEL shall supply additional manpower & machinery depending upon the field requirement. M/s BHEL to note and confirm.	in TCM	confirmed that the 'MANPOWER requirement is in line with the project time schedule. L1 PERT & depending upon the peak Civil activities at site M/s. BHEL shall supply adequate manpower & machinery depending upon the field requirement'. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Civil (Annexure-5.2)	
WRITE UP	
Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)	ANNEXURE 5.2

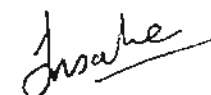
Note:

1. Bidder may please note that except deviation points accepted by Owner, the tender specification prevails and binding to the bidder. TCM Resolution: During the meeting, M/s BHEL noted and confirmed.
2. In case of any mismatch /discrepancies/contradiction between bidder's technical write-up/ offer and tender specification, the specification will prevail. TCM Resolution: During the meeting, M/s BHEL noted and confirmed.
3. In case of any mismatch /discrepancies/contradiction in tender specification, the stringent will prevail. TCM Resolution: During the meeting, M/s BHEL noted and confirmed.

M/s NLCIL



M/s DCPL (Consultant)



M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.3)

SUB VENDORS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.3

Sl. No	Tender Specification Reference		As Per Bid Document	NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement				
1.	Vol-IIA/ Section-III/ Annexure-1/ Page 14 -16 of 16	List of Sub Vendors - Civil & Structural Supply Portion	M/s BHEL have furnished a Partial Civil sub vendor list.	For some of the Civil supply portion items M/s BHEL have mentioned as ' <i>shall be provided during execution</i> ' which is not acceptable to NLCIL/DCPL. For these items also M/s BHEL shall submit proposed sub-vendors and re-submit the Civil sub vendor list with in one week time to NLCIL/ DCPL as stipulated in the Tender specification vide Vol-IIA/Section-III/ Annexure-1/ Page 14 - 16 of 16, to enable NLCIL / DCPL to categorise the list into Category I / Category II in line with Vol IIA, Section-III, Annexure-1/ General (d)/ Page 9 of 16.	To be discussed in TCM	During the meeting M/s BHEL was informed to re-submit the Civil sub-vendor list in line with TS requirements on or before 25.01.2021. NLCIL/DCPL informed that the consolidated and categorised list of sub vendors will be communicated to the bidder separately. M/s BHEL noted and confirmed. NLCIL/DCPL Noted.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Civil (Annexure-5.3)	
SUB VENDORS	
Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)	ANNEXURE 5.3

Sl. No	Tender Specification Reference		As Per Bid Document	NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement				
				M/s BHEL to confirm.		
				M/s BHEL has proposed sub vendors for Wind tunnel test for chimney which is not specified in the sub vendor list of tender specification. Hence this shall be deleted from the sub vendor list by BHEL. However, in respect of agency for conducting wind tunnel test, M/s BHEL shall follow Vol-II/Sec-I Part-B/Sub Sec-I/ Cl. 1.01.0. M/s BHEL to note and confirm.	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the TS requirement without any Price implication. M/s BHEL agreed to carryout the wind tunnel test for chimney based on TS requirements. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.4)

DRAWINGS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.4

Sl. No	Tender Specification Reference		As Per Bid Document	NLCIL/DCPL Comments	Bidder's Reply	TCM Resolution
	Vol/Clause/ Page No.	TS Requirement				
1.	-	CIVIL TENDER DRAWINGS	M/s BHEL have not furnished any Civil tender drawings along with their Bid offer.	Noted. However, Bidder is requested to confirm that all the drawings/ system is offered strictly in compliance with tender specification except the deviation points accepted by Owner. In case of any mismatch / discrepancies/ contradiction between bidder's drawings and tender specification, the technical specification will prevail. In case of any mismatch / discrepancies/ contradiction in tender specification, the stringent will prevail. M/s BHEL to note and confirm.	Shall be discussed during TCM.	During the meeting M/s BHEL noted and confirmed to the NLCIL/DCPL comments. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Civil (Annexure-5.5)	
COMMON POINTS	
Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)	ANNEXURE 5.5

Sl. No.	Details	Bidders reply	TCM Resolution
1.	Deviations accepted in one place are also applicable for same stipulation elsewhere in the specification. Bidder is requested to confirm.	Confirmed	NLCIL/DCPL noted the reply furnished by the bidder. Point closed.
2.	Bidder is requested to confirm that their offer is for the complete scope as per Tender specification. Other than the agreed deviations, the bidder confirms to Technical specification requirements, tender drawings and supplies the materials and services as per the scope to meet system requirement.	BHEL confirms compliance to tender conditions read in conjunction with amendments/ resolution to post bid discussions/ subsequent amendments/ approvals.	NLCIL/DCPL noted the reply furnished by the bidder. Point closed.
3.	As the bidder has not taken any deviation to the time schedule, Bidder is requested to confirm the time schedule as per tender specification.	Confirmed	NLCIL/DCPL noted the reply furnished by the bidder. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu	
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant	
Techno Commercial Meeting dated 18.01.2021	
Civil (Annexure-5.5)	
COMMON POINTS	
Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)	ANNEXURE 5.5

4.	Bidders should strictly comply with the material specified in tender specification. In case bidder is proposing alternate material, [wherever specifically allowed in tender specification]; bidder is requested to establish with supporting document and evidence, that his proposed material is 'at least equivalent or superior' to that mentioned in tender specification. Bidder's explanation and justification should meet the entire satisfaction and full acceptance of Owner/ Consultant.	BHEL confirms compliance to tender conditions read in conjunction with amendments/ resolution to post bid discussions/ subsequent amendments/ approvals	NLCIL/DCPL noted the reply furnished by the bidder. Point closed.

Enclosure-5.5, Revised Technical specification (TS) Requirement:

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
1.	Volume: II-B/ Section: I; Part B; Sub Section: I/ Cl. 1.07.00 / 10 of 28	The material of gutter including drain and base plates shall be made of suitable alloy steel to withstand design operating environment.	The material of gutter including drain and base plates shall be made of suitable alloy steel (C276) to withstand design operating environment.	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement with Price Implication. NLCIL/DCPL noted.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
					Point closed.
2.	Volume: II-B/ Section: I; Part B; Sub Section: I/ Cl. 1.01.00 / 3 of 28	Wind Tunnel Study shall be conducted in any one of the following approved Lab/Institute - SERC-Chennai, IISC-Bangalore & IIT-Kanpur and the study report shall be got approved by the Purchaser / Consultant.	Wind Tunnel Study shall be conducted in any one of the following approved Lab/Institute - SERC-Chennai or IIT-Kanpur and the study report shall be got approved by the Purchaser / Consultant.	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement Without any Price Implication.
	Volume: II-B/ Section: I; Part B; Sub Section: I/ Cl. 4.01.03 / 13 of 28				NLCIL/DCPL noted. Point closed.
3.	Volume: II-B Section: I; Part C; Sub Section: I/ Cl. 2.00.00/Page 1 of 19	- New clause added	The successful bidder shall carryout the following Geotechnical Investigation as deemed fit: a) 3 no. Bore holes up to 30 m depth below ground level irrespective of soil/rock strata	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement without any Price Implication. NLCIL/DCPL noted.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
			encountered. b) Laboratory tests (as specified) on soil and rock samples collected from the bore holes. c) Chemical analysis of water (2 nos.) and sub soil samples. d) 2 no. ERT tests. e) 1 no. Cross hole shear wave test. f) 2 no. Field CBR tests and two laboratory CBR tests. The above list is not exhaustive. In case, the bidder feels that the additional tests are required; he/she is at liberty to carryout such additional tests without any additional cost to the owner.		Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
			Also refer Vol-II B Sec-I/ Part A/ Sub sec-I.		
4.	Volume: II-B Section: I; Part A; Sub Section: I/ Cl. 1.00.00 Scope	- New clause added	Note: This section is a general guideline for Geo-technical Investigation covering all general tests in soil and rock. However, the successful bidder shall carryout the following Geotechnical Investigation as deemed fit: a) 3 no. Bore holes up to 30 m depth below ground level irrespective of soil/rock strata encountered. b) Laboratory tests (as specified) on soil and rock samples collected from the bore holes. c) Chemical analysis of water (2	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement without any Price Implication. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined BI-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
			nos.) and sub soil samples. d) 2 no. ERT tests. e) 1 no. Cross hole shear wave test. f) 2 no. Field CBR tests and two laboratory CBR tests. The above list is not exhaustive. Incase, the bidder feels that the additional tests are required; he/she is at liberty to carryout such additional tests without any additional cost to the owner.		
5.	Volume: II-B/ Section: I; Part A; Sub Section: VI/ CI. 3.02.00/page 7&8 of 22	C) Lateral Capacity The Lateral capacity of single pile, at this site, will be considered as the minimum of the following:-	C) Lateral Capacity Lateral pile capacity assessed by the successful contractor decided by the contractor & purchaser.	Noted with price implication.	During the meeting NLCIL / DCPL informed that the existing TS requirements in respect of the Lateral capacity shall prevail.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

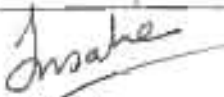
Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
		i) 5% of their respective compressive capacity of pile ii) Lateral pile capacity assessed by the successful contractor decided by the contractor & purchaser.			M/s BHEL Noted and confirmed to existing TS requirement without any Price Implication. NLCIL/DCPL noted. Point closed.
6.	Vol. II-B, Section 1, Part B, Sub Section 1, Cl. 1.06.00.i), Page No. 4 of 28	Treated flue 2 mm thick Titanium sheet. The design design guide.	Treated flue 2 mm thick Titanium sheet (Grade 2 as per ASME SB265). The design design guide.	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement without any Price Implication. NLCIL/DCPL noted. Point closed.
	Vol. II-B, Section 1, Part B, Sub Section 1, Cl.	The insulation 2mm thick Titanium/ C276 sheet cladding carried out.	The insulation 2mm thick Titanium (Grade 2 as per ASME SB265) sheet cladding carried out.		

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined BI-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
	1.06.00.vii), Page No. 6 of 28				
7.	Volume: II-B Section: I; Part B; Sub Section: I/ Cl. 6.01.00 (7) / 17 of 28	Openings in the shell not more than 30° subtended at the center of the concrete shell. The total plan area more than 15% of the plan area	Openings in the shell not more than 45° subtended at the center of the concrete shell. The total plan area more than 20% of the plan area	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement without any Price Implication. NLCIL/DCPL noted. Point closed.
8.	Volume: II-B Section: I; Part A; Sub Section: I/ Cl. 3.01.00 / 5 of 26	Where possible.....when directed by the Engineer.	This Paragraph stands deleted.	-	During the meeting M/s BHEL noted and confirmed to the revised TS requirement. NLCIL/DCPL noted. Point closed.

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Cause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
9.	General (Wherever applicable)	IS 8112	IS 269 (Latest revision)	-	During the meeting M/s BHEL noted and confirmed to the revised TS requirement. NLCIL/DCPL noted. Point closed.
10.	Volume: II-B Section: I; Part A; Sub Section: VI/ Cl. 3.01.00 / 11 of 23	Fabrication: Fabrication may be either shop fabricated or Site fabricated	Fabrication: Fabrication may be either shop fabricated or Site fabricated	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement without any Price Implication. NLCIL/DCPL noted. Point closed.
11.	Volume: II-B Section: I; Part B; Sub Section:	A common Nickel based alloy material of suitable material for the operating	The condensate collection system in this package includes condensate from FGD outlet up to flue can top.	-	During the meeting M/s BHEL noted and confirmed to the revised TS requirement

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
	I/ Cl. 1.06.00 (v) / 5 of 28	duty. The condensate collection system in this package includes condensate from FGD outlet up to flue can top.	The condensate from the flue cans and FGD outlet duct to chimney shall be connected to the condensate collection tank which only is in the Purchaser's scope. However the condensate downcomer drain pipe from the chimney to the collection tank is in the scope of the Additional Chimney contractor. (The condensation collection tank is in the scope of Purchaser).		with Price implication, NLCIL/DCPL noted. Point closed.
12.	Volume: II-B Section: I; Part B; Sub Section: I/ Cl. 6.01.00 (7) / 17 of 28	Puddle Flange Puddle flange located at the bottom of soot hopper shall be lined with High nickel alloy material for protection from acidic ash.	This sentence stands deleted	-	During the meeting, M/s NLCIL/DCPL clarified that the puddle flange requirement at the bottom of flue can in the wet chimney doesn't arise, since there will not be dry ash

M/s NLCIL

M/s DCPL (Consultant)

M/s BHEL

NLC Tamilnadu Power Ltd. (NTPL 2x500 MW Project), Tuticorin, Tamilnadu

Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant

Techno Commercial Meeting dated 18.01.2021

Civil (Annexure-5.5)

COMMON POINTS

Bidder: M/s Bharat Heavy Electricals Limited. (BHEL)

ANNEXURE 5.5

Sl. No.	Vol/Chapter/Cause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
					accumulation. M/s BHEL noted and confirmed to the revised TS requirement with Price implication . NLCIL/DCPL noted Point closed

M/s NLCIL


M/s DCPL (Consultant)


M/s BHEL

ANNEXURE - I

NLC TAMILNADU POWER LIMITED (NTPL 2x500 MW Project), Tuticorin, Tamilnadu
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant
Price Implication - Commercial & Technical
Bidder: M/s. Bharat Heavy Electricals Limited (BHEL)

Deviation						Annexure 5.1		
Sl. No.	Sl. No Ann. 5.1	Tender Specification Reference		Offer Reference		NLCIL/DCPL Reply	Bidder's Reply	TCM Resolution
		Vol/Clause / Page No.	TS Requirement	Vol/Clause/ Page No.	Deviation (or) Offer Details			
3.	3	General	-	Sl. No.3 of Schedule-F4 (Deviation Schedule to Technical Specification)	It is understood that multiple brand of Cements can be used for Construction of Chimney Shell.	Not acceptable. Tender condition prevails. M/s. BHEL shall withdraw the deviation taken. M/s BHEL to note and confirm.	To be discussed in TCM	During the meeting, NLCIL/ DCPL informed that the request of M/s BHEL is not acceptable to NLCIL/DCPL. Hence, M/s BHEL withdrew the deviation taken and confirmed compliance to Tender specification with Price Implication. NLCIL/DCPL noted. Point Closed.

Annexure-5.5

Enclosure-5.5, Revised Technical specification (TS) Requirement:

Sl. No	Sl. No. in Ann-5.5 (Enclosure)	Vol/Chapter/Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
4.	1	Volume: II-B/ Section: I; Part B; Sub Section:	The material of gutter including drain and base plates shall be made of	The material of gutter including drain and base plates shall be made of suitable alloy steel (C276)	Noted with price implication.	During the meeting M/s BHEL noted and confirmed to the revised TS requirement with Price Implication.

ANNEXURE - I

NLC TAMILNADU POWER LIMITED (NTPL 2x500 MW Project), Tuticorin, Tamilnadu
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant
Price Implication - Commercial & Technical
Bidder: M/s. Bharat Heavy Electricals Limited (BHEL)

Annexure-5.5

Enclosure-5.5, Revised Technical specification (TS) Requirement:

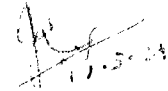
Sl. No	Sl. No. in Ann-5.5 (Enclosure)	Vol/Chapter/Cause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
		I/ Cl. 1.07.00 / 10 of 28	suitable alloy steel to withstand design operating environment.	to withstand design operating environment.		NLCIL/DCPL noted. Point closed.
5.	11	Volume: II-B Section: I; Part B; Sub Section: I/ Cl. 1.06.00 (v) / 5 of 28	A common Nickel based alloy material of suitable material for the operating duty. The condensate collection system in this package includes condensate from FGD outlet up to flue can top.	The condensate collection system in this package includes condensate from FGD outlet up to flue can top. The condensate from the flue cans and FGD outlet duct to chimney shall be connected to the condensate collection tank which only is in the Purchaser's scope. However the condensate downcomer drain pipe from the chimney to the collection tank is in the scope of the Additional Chimney contractor. (The condensation collection tank is in the scope of Purchaser).	-	During the meeting M/s BHEL noted and confirmed to the revised TS requirement with Price implication. NLCIL/DCPL noted. Point closed.
6.	12	Volume: II-B Section: I; Part B; Sub Section: I/ Cl. 6.01.00	Puddle Flange Puddle flange located at the bottom of soot	This sentence stands deleted	-	During the meeting, M/s NLCIL/DCPL clarified that the puddle flange requirement at the bottom of flue can in the wet chimney doesn't

ANNEXURE - I

NLC TAMILNADU POWER LIMITED (NTPL 2x500 MW Project), Tuticorin, Tamilnadu
Construction of One RCC Additional Chimney of 150 M height with Borosilicate lined Bi-flue can arrangement for FGD Plant
Price Implication - Commercial & Technical
Bidder: M/s. Bharat Heavy Electricals Limited (BHEL)

Annexure-5.5**Enclosure-5.5, Revised Technical specification (TS) Requirement:**

Sl. No	Sl. No. in Ann-5.5 (Enclosure)	Vol/Chapter/Cause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply	TCM Resolution
		(7) / 17 of 28	hopper shall be lined with High nickel alloy material for protection from acidic ash.			arise, since there will not be dry ash accumulation. M/s BHEL noted and confirmed to the revised TS requirement with Price implication. NLCIL/DCPL noted. Point closed.



for General Manager/Contracts & IE



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : D

REV.NO. 00

SHEET

2X500 MW NTPL TUTICORIN CHIMNEY PACKAGE

VOLUME II-B

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

SECTION – D GENERAL TECHNICAL REQUIREMENTS

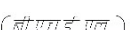
(RCC CHIMNEY)

**SPECIFICATION NO. PE-TS-490-620-C002
REV-00**



Bharat Heavy Electricals Limited

**Project Engineering Management
Power Sector, PPEI BUILDING, Plot No-25
SECTOR 16A, NOIDA-201301, UP**

 Maharatna Company	TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY PACKAGE SPECIFICATIONS FOR RCC CHIMNEY	SPECIFICATION NO. PE-TS-490-620-C002
		VOLUME : IIB
		SECTION : D
		REV.NO. 00
		SHEET

PREAMBLE

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

Technical requirements are stipulated in this Volume which comprises of

Section C : This section indicates the technical requirements specific to the contract not covered in Section D

Section D : This section comprises of technical specification(s)

The requirements mentioned in the Section C shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the Section D in the specification. In case on any conflict between technical specification and BOQ, BOQ shall prevail.



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : D

REV.NO. 00

SHEET

INDEX

SECTION	DESCRIPTION

Section-C	SPECIFIC TECHNICAL REQUIREMENTS

Section-D	SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

Sub-section D2: Cement concrete (Plain and reinforced) and formwork

Sub-section D3: Carpentry and joinery

Sub-section D4: Roof and underground structures water proofing, insulation and allied works

Sub-section D5: Metal doors, windows, ventilators, louvers etc.

Sub-section D6: Glass and glazing.

Sub-section D7: Rolling Steel Shutter and Grills

Sub-section D8: Miscellaneous Metal

Sub-section D9: Masonry and allied works

Sub-section D10: Finish to masonry and concrete

Sub-section D11: Painting, Whitewashing, polishing

Sub-section D12: Floor finish and allied works

Sub-section D13: Sheet work in roof and siding

Sub-section D14: Suspended ceiling

Sub-section D15: Water supply, drainage & sanitation

Sub-section D16: Road and drainage

Sub-section D17: Fabrication of structural steelwork

Sub-section D18: Erection of structural steelwork

Sub-section D19: Roof decking

Sub-section D20: False flooring

Sub-section D23: Anti termite

Sub-section D24: Quality Assurance & Inspection



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : D

REV.NO. 00

SHEET

Sub-section D25: RCC stack

Sub-section D26: Borosilicate glass block lining system

Section-C & SECTION-D CHIMNEY ELECTRICAL WORKS

Section-C & SECTION-D CHIMNEY ELEVATOR WORKS



**TITLE: 2X500 MW NTPL TUTICORIN CHIMNEY
PACKAGE**

SPECIFICATIONS FOR RCC CHIMNEY

SPECIFICATION NO. PE-TS-490-620-C002

VOLUME : IIB

SECTION : D

REV.NO. 00

SHEET

SECTION-D

GENERAL TECHNICAL REQUIREMENTS



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 56

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

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)



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



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 56

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	INSTALLATION	12
4.00.00	SAMPLING AND TESTING	41
5.00.00	ACCEPTANCE CRITERIA	43
6.00.00	RATES AND MEASUREMENTS	43
7.00.00	LIST OF I.S.: CODES AND STANDARDS FOR REFERENCE	51



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 56

SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

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

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 56

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

- i) The various ingredients of concrete
- ii) Concrete
- iii) Embedments
- iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

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

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be adopted.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 56

- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

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

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 56

c) Design Mix

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

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00

Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 7 OF 56

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 **Cement**

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 **Coarse Aggregate**

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 8 OF 56

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture
- e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 9 OF 56

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTM C-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

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

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 10 OF 56

edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

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

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.
	For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 11 OF 56

Material tests or Certificates to satisfy relevant IS Specification.

- g) Grades of Concrete: Usage and mix design, testing of all properties.
- h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
- j) Embedded and Anchorage Items: Material, shape, location, setting.
- k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
- l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00

INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 12 OF 56

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 13 OF 56

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 14 OF 56

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

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

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 15 OF 56

3.07.02

Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00

Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 16 OF 56

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

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

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 17 OF 56

Ordinary Plain concrete and Reinforced
concrete foundations - 40 mm

Mass concrete - 80 mm

Lean concrete - 40 mm

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

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

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 18 OF 56

shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

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

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 19 OF 56

3.12.00

Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 20 OF 56

placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 21 OF 56

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

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

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 22 OF 56

placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 23 OF 56

- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair & mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes,



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 24 OF 56

ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 25 OF 56

acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 26 OF 56

other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 27 OF 56

Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by -volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 28 OF 56

contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 29 OF 56

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 30 OF 56

3.20.04

Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05

Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06

Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- a) Sectional dimension - ± 5 mm
 - b) Plumb - 1 in 1000 of height
 - c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 31 OF 56

taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 32 OF 56

to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

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

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 33 OF 56

laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 34 OF 56

the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 35 OF 56

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 36 OF 56

Maximum Safe Continuous
Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 37 OF 56

3.25.00

Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00

Waterproofing of Concrete Structure

3.26.01

General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 38 OF 56

Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02

Water Bar/Seal/Special Treatment of Construction Joint

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

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

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 39 OF 56

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

3.26.03

Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04

Structural waterproofing

- a) Nozzles spaced as required after the concrete is completed shall be drilled



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 40 OF 56

into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

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

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

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

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

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



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 41 OF 56

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

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

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



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 42 OF 56

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 43 OF 56

and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

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

5.02.00 Acceptance Criteria

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

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 44 OF 56

strength.

If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.
- b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include all arrangement for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 45 OF 56

payable to the contractor as per BOQ item.

- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.
- b) No deductions shall be made for the following:
 - i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;
 - ii) Opening upto 0.1 sq.m.
 - iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23°C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 46 OF 56

- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.
- c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.
- d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 47 OF 56

- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 48 OF 56

shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.
- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 49 OF 56

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.
- f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightness shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

- a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

- b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

- c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 50 OF 56

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 51 OF 56

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

- IS: 73 - Indian Standard Specification for Paving Bitumen
- IS: 216 - Indian Standard Specification for Coal Tar Pitch
- IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
- IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
- IS: 455 - Indian Standard Specification for Slag Cement
- IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete
- IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 52 OF 56

Structures

- IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete
- IS: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
- IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
- IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement
- IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
- IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
- IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.
- IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
- IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks
- IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates
- IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 53 OF 56

- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS: 2571 - Code of practice for laying in-situ cement concrete floors.
- IS: 2645 - Integral cement water proofing compound
- IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batches for Concrete (Single and Double Bucket type)
- IS: 2750 - Indian Standard Specification for steel scaffoldings.
- IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
- IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
- IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
- IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses
- IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- IS: 3414 - Code of practice for design and installation of joints in buildings.
- IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
- IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete
- IS: 3696 - Safety Code for Scaffolding and Ladders
- IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
- IS: 4014 - Code of practice for steel tubular scaffolding.
- IS: 4031 - Indian Standard Specification for Method of Tests for



TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 54 OF 56

Hydraulic Cement

- IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
- IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches
- IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes
- IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete
- IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant
- IS: 4926 - Indian Standard Specification for Ready Mixed Concrete
- IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work
- IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground
- IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
- IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.
- IS: 5256 - Code of practice for sealing joints in concrete lining on canals.
- IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials
- IS: 5513 - Indian Standard Specification for vacate Apparatus.
- IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.
- IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS: 5624 - Indian Standard Specification for foundation bolts.
- IS: 5751 - Indian Standard Specification for Precast Concrete Coping



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 55 OF 56

Blocks.

- IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.
- IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.
- IS: 5892 - Indian Standard Specification for transit mixer and agitators.
- IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS: 6909 - Indian Standard Specification for Super sulphated Cement
- IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
- IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
- IS: 7242 - Indian Standard Specification for Concrete Spreaders.
- IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.
- IS: 7251 - Indian Standard Specification for Concrete Finishers.
- IS: 7293 - Safety code for working with construction machinery.
- IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.
- IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.
- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.



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

SPECIFICATION NO. PE-TS-999-600-C002

VOLUME - II B

SECTION - D SUB SECTION - D2

REV.NO. 0 DATE : 30/11/2015

SHEET 56 OF 56

- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shortcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.
- IS: 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS: 10262 - Recommended Guidelines for Concrete Mix Design.
- IS: 13311 - Non-destructive testing of concrete.
- SP: 34 - Handbook of concrete, reinforcement and detailing.



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 1 OF 7

VOLUME: II B

SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003



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



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 2 OF 7

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	6
5.00.00	RATES AND MEASUREMENTS	6



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 3 OF 7

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number of joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 4 OF 7

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 5 OF 7

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmet, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.



TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 6 OF 7

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)

IS: 1003 - Timber panelled and glazed shutters.

IS: 2191 - Wooden flush door shutter (Cellular and hollow core type).

IS: 2202 - Wooden flush door shutters (solid core type).

IS: 4021 - Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,



**TECHNICAL SPECIFICATION
FOR CARPENTRY AND
JOINERY**

SPECIFICATION NO. PE-TS-999-600-C003

VOLUME - II B

SECTION - D SUB SECTION - D3

REV.NO. 0 DATE : 30/11/2015

SHEET 7 OF 7

holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 1 OF 15

VOLUME: II B

SECTION – D

SUB-SECTION – D4

**ROOF AND UNDERGROUND STRUCTURES WATER
PROOFING, INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004



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



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 2 OF 15

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE	13
4.00.00	I.S. CODES AND STANDARDS	14
5.00.00	RATES AND MEASUREMENTS	15



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 3 OF 15

**ROOF AND UNDERGROUND WATER PROOFING,
INSULATION AND ALLIED WORKS**

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 4 OF 15

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 5 OF 15

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 6 OF 15

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fibre base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 7 OF 15

- 3) Fibre base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fibre base self-finished felt, type 2, grade 2.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fibre based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fibre-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 8 OF 15

- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 7) Hessian base self-finished felt, type 3, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02

Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C 836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300%



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 9 OF 15

elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkali and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane is applied.

c) Finishing coats:

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish:

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 10 OF 15

and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing by Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 11 OF 15

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01

Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose, drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 12 OF 15

- ii) Hot applied bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base bitumen felt type 3 grades 2
- iv) Hot applied bitumen at the rate 1.2 Kg/m²
- v) Hessian base bitumen felt type 3 grades 2
- vi) Hot applied bitumen at the rate of 1.2 Kg/m²
- vii) Hessian base bitumen felt type 3 grades 2
- viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 13 OF 15

3.00.00

ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years.

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 14 OF 15

4.00.00

I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and waterproofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C004

VOLUME - II B

SECTION - D SUB SECTION - D4

REV.NO. 0 DATE: 03/10/2017

SHEET 15 OF 15

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labor, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005
VOLUME - II B
SECTION - D | SUB-SECTION – D5
REV.NO. 00 DATE 03/10/2017
SHEET 1 OF 15

VOLUME: II B

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-999-600-C005



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



TITLE:
**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005
VOLUME - II B
SECTION - D | SUB-SECTION – D5
REV.NO. 00 DATE 03/10/2017
SHEET 2 OF 15

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	INFORMATION TO BE SUBMITTED	9
5.00.00	I.S. CODES	10
6.00.00	RATES AND MEASUREMENTS	10

ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 15

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 15

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware's where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 15

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18-gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Jindal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 15

2.02.02

Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15-micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00

Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00

Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 7 OF 15

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00

Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one meters from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 15

2.06.0**Fire proof Door**

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614 (Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open outside.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00**ACCEPTANCE CRITERIA****3.01.00****For fabricated Items**

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures
- h) Provision for hardware and fixtures to be installed at site.
- i) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 9 OF 15

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

- a) Installations shall be at correct location, elevation and in general, on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

- a) Names of manufacturers for Doors, windows etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

- a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 10 OF 15

- b) He shall submit a programme of work to be done for the approval of the Engineer.
- c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00

IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 00 DATE 03/10/2017

SHEET 11 OF 15

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per "Schedule of Items".

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminum shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminum partition frames shall be in Kg. Paneling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in Sqm in net area outer to outer of the door.



TITLE:
**TECHNICAL SPECIFICATION
 FOR METAL DOORS, WINDOWS,
 VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005			
VOLUME - II B			
SECTION - D		SUB-SECTION - D5	
REV.NO.	00	DATE	03/10/2017
SHEET	12	OF	15

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

- i) 100 mm brass butt hinges with screws - 3 Nos.
- ii) 150 mm brass tower bolts with screws - 1 No.
- iii) 100 mm x 225 mm clear plastic push
Plate with counter sunk brass screws - 1 No.
- iv) 30 mm brass ring pull handle with
Plates and screws - 1 No.
- v) 150 mm brass coat hook with screws - 1 No.

vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

- i) Concealed hanging arrangement for door leaves.
- ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.
- iii) Heavy duty, cylinder look on active leaf.
- iv) Pull handle of approved design on both leaves.
- v) Doors stops for both leaves.
- vi) Overhead door closure for both leaves.



TITLE:
**TECHNICAL SPECIFICATION
 FOR METAL DOORS, WINDOWS,
 VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005			
VOLUME - II B			
SECTION - D		SUB-SECTION – D5	
REV.NO.	00	DATE	03/10/2017
SHEET	13	OF	15

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

- i) 100 mm butt hinges - 3 Nos. on each leaf.
- ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom)
On inside of inactive
Leaf. 1. No. (Top only)
On inside active leaf.
- iii) 200 mm anodized aluminum
pull handle - 1 No. of each leaf.
- iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

- i) 100 mm butt hinges - 3 Nos.
- ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside
face
- iii) 200mm anodised aluminum
Pull handle - 1 No.
- iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) 12" peg stays - 1 No. per leaf



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION – D5

REV.NO. 00 DATE 03/10/2017

SHEET 14 OF 15

ANNEXURE-A

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assemblies - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.



TITLE:

**TECHNICAL SPECIFICATION
FOR METAL DOORS, WINDOWS,
VENTILATORS, LOUVERS ETC.**

SPECIFICATION NO. PE-TS-999-600-C005

VOLUME - II B

SECTION - D | SUB-SECTION – D5

REV.NO. 00 DATE 03/10/2017

SHEET 15 OF 15

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.

(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) 300 mm peg stays	- 1 No per leaf
iii) 2 point handles	- 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) Adjustable sliding fabrication assemblies	- 2 Nos. per leaf
iii) 2 Point handles	- 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) Concealed side arms for opening adjustment	- 2 Nos. per leaf
iii) Spring Catch	- 1 No. per leaf



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION – D6

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 5

VOLUME: II B

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006



Bharat Heavy Electricals Limited

Project Engineering Management

PPEI Building, Power Sector,

Plot No. 25, Sector 16A,

Noida (U.P.)-201301



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION – D6

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 5

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	I.S. CODES	4
5.00.00	RATES	5



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION - D6

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 5

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials:

- a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.
- c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.
- d) Obscure glasses shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.
- g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D

SUB-SECTION - D6

REV.NO. 00

DATE 03/10/2017

SHEET

4

OF

5

2.03.00

Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes where six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00

ACCEPTANCE CRITERIA

- a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.



TITLE:

**TECHNICAL SPECIFICATION
FOR GLASS AND GLAZING**

SPECIFICATION NO. PE-TS-999-600-C006

VOLUME - II B

SECTION - D SUB-SECTION – D6

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 5

4.00.00 I.S. CODES

Following are some of the important I.S. Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D

SUB-SECTION – D7

REV.NO. 00

DATE 03/10/2017

SHEET 1

OF 5

VOLUME: II B

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-999-600-C007



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D

SUB-SECTION - D7

REV.NO. 00

DATE 03/10/2017

SHEET

2

OF

5

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D SUB-SECTION - D7

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 5

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia. rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20-gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROLLING STEEL SHUTTERS AND
GRILLS**

SPECIFICATION NO. PE-TS-999-600-C007

VOLUME - II B

SECTION - D SUB-SECTION - D7

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 5

- i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

- j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.
- k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters

	TITLE: TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS	SPECIFICATION NO. PE-TS-999-600-C007 VOLUME - II B SECTION - D SUB-SECTION – D7 REV.NO. 00 DATE 03/10/2017 SHEET 5 OF 5
	and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules. 3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE 3.01.00 Shop Inspection After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings. 3.02.00 Field Inspection After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance. 3.03.00 Guarantee The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters. 4.00.00 I.S. CODE IS: 6248 - Metal rolling shutters and rolling grills. 5.00.00 RATES AND MEASUREMENT 5.01.00 Rates Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor. 5.02.00 Measurement Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in "Schedule of Items".	



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 9

VOLUME: II B

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-999-600-C008



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



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 9

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	7
4.00.00	IS CODES	8
5.00.00	RATES AND MEASUREMENTS	8



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION - D8

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 9

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 9

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, then those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 9

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer's instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION - D8

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 9

- c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consist of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The Dia. shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wires for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 7 OF 9

steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02

Barbed Wire Fencing

The barbed wire shall be conforming to IS:278 latest editions. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two-line wire and two-point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one-line wire (Type A - around both line wire, Type B - around one-line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75±12mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 9

evenly spaced row of line wire in all. The top line wire shall be doubled, making five-line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from, straightness – 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanized Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanized Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy



TITLE:
TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL SIDING

SPECIFICATION NO. PE-TS-999-600-C008

VOLUME - II B

SECTION - D SUB-SECTION – D8

REV.NO. 00 DATE 03/10/2017

SHEET 9 OF 9

5.00.00 RATES AND MEASUREMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.

Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



**TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 1 OF 12

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009



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



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 2 OF 12

C O N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	6
4.00.00	I.S. CODES	10
5.00.00	RATES AND MEASUREMENTS	11



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 3 OF 12

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours' immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours'



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 4 OF 12

immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 5 OF 12

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 6 OF 12

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days' work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborundum stone shall be used for rubbing down.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 8 OF 12

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by especially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 9 OF 12

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days' work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double Chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 10 OF 12

Where shown on drawing, damp proof membrane with one-layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.06.00

Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly over burnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 11 OF 12

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00

I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00

RATES AND MEASUREMENTS

5.01.00

Rates

Unit rate for masonry work shall include the following:

- Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- Preparing top sand sides of existing wall for joining old with new work.
- Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.



TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

VOLUME - II B

SECTION - D SUB SECTION - D9

REV.NO. 0 DATE: 03/10/2017

SHEET 12 OF 12

5.02.00

Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.
- d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 sqm in section;
- e) Chases of section not exceeding 50 cm in girth;
- f) Iron fixtures, such as wall ties and hold fasts for doors and windows;
- g) Cement concrete blocks as for hold fasts and holding down bolts;
- h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.



**TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND CONCRETE**

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 1 OF 9

VOLUME: II B

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010



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



**TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND CONCRETE**

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 2 OF 9

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	I.S. CODE	8
5.00.0	RATES AND MEASUREMENTS	9



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 3 OF 9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items, the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 4 OF 9

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be

mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 5 OF 9

2.02.03

Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1-part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 6 OF 9

Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1-part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 7 OF 9

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1-part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1-part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 8 OF 9

lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1-part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.



TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

VOLUME - II B

SECTION - D SUB SECTION - D10

REV.NO. 0 DATE: 03/10/2017

SHEET 9 OF 9

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall be measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION – D11

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 13

VOLUME: II B

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011



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



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011
VOLUME - II B
SECTION - D SUB-SECTION – D11
REV.NO. 00 DATE 03/10/2017
SHEET 2 OF 13

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND TESTING	10
4.00.00	I.S. CODES AND STANDARDS	11
5.00.00	RATES AND MEASUREMENTS	12



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 13

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of Paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION – D11

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 13

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 13

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not be yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well-known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pre-treated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02

Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00

Preparation of surface

Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 13

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477 (Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc. and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrapers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 7 OF 13

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 13

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1-part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers, the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION – D11
 REV.NO. 00 DATE 03/10/2017
 SHEET 9 OF 13

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conforming to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primed surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION - D11

REV.NO. 00 DATE 03/10/2017

SHEET 10 OF 13

hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.



TITLE:
**TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011

VOLUME - II B

SECTION - D SUB-SECTION – D11

REV.NO. 00 DATE 03/10/2017

SHEET 11 OF 13

3.00.00

ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.



TITLE:
**TECHNICAL SPECIFICATION FOR
 PAINTING, WHITEWASHING,
 POLISHING**

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION – D11
 REV.NO. 00 DATE 03/10/2017
 SHEET 12 OF 13

Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00

I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.



TITLE:
TECHNICAL SPECIFICATION FOR
PAINTING, WHITEWASHING,
POLISHING

SPECIFICATION NO. PE-TS-999-600-C011
 VOLUME - II B
 SECTION - D SUB-SECTION – D11
 REV.NO. 00 DATE 03/10/2017
 SHEET 13 OF 13

IS: 2338 Code of Practice for finishing of wood and
 (I & II) wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in
 dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster
 surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the “Schedule of
 Items”.

Rate shall include cleaning, preparation of surface, supply and application of
 primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on
 the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of
 beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill
 of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not
 exceeding 3.0 Sqm each and no addition shall be made for reveals, jams,
 soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for
 opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be
 increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel
 (as per section D-17 clause 6.02.00 i.e. Mode of measurement of technical
 specification for fabrication of structural steel works) unless specified
 otherwise.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 22

VOLUME: II B

SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C012



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



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 22

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	4
3.00.00	ACCEPTANCE CRITERIA	20
4.00.00	I.S. CODES	21
5.00.00	RATES AND MEASUREMENTS	21



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 22

FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

- i) Integral finish to concrete base
- ii) Terrazzo finish
- iii) Granolithic finishes
- iv) Patent Stone
- v) Metallic Hardener like “Ironte”/Hardonate Finish
- vi) Mastic Asphalt finishes
- vii) Chemical Resistant finish

b) Tiled Finishes

- i) Terrazzo tile
- ii) Chequered tile
- iii) Glazed tile
- iv) Tesse rae (Mosaic etc.)
- v) Chemical Resistant
- vi) Rubber, Vinyl etc.
- vii) Stone Slab including Kota Stone.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 22

detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish to Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to achieve the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 22

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1-part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1-part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 7 OF 22

topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine cannot be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03

Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 22

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1-part cement, 1-part coarse sand, 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary, the surface of the base shall be roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 9 OF 22

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1-part cement and 2-part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 10 OF 22

a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ 'Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1-part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 11 OF 22

The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 12 OF 22

quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the

**TITLE:****TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 13 OF 22

thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) **Mix: Underbed**

The underbed for floor and similar horizontal surfaces shall be 1-part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1-part cement and 3 parts coarse sand by weight.

d) **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 14 OF 22

joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 15 OF 22

- d) Laying
As per clause 2.02.01 (d).

- e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

- a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

- b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawling, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 16 OF 22

c) Mix: Underbed

The mix for the underbed shall consist of 1-part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying

Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed

Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 17 OF 22

mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

**TITLE:****TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 18 OF 22

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1-part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 19 OF 22

joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed

Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to



TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION - D12

REV.NO. 00 DATE 03/10/2017

SHEET 20 OF 22

stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall

be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally, clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form an inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture

	TITLE: TECHNICAL SPECIFICATION FOR FLOOR FINISH AND ALLIED WORKS	SPECIFICATION NO. PE-TS-999-600-C012 VOLUME - II B SECTION - D SUB-SECTION – D12 REV.NO. 00 DATE 03/10/2017 SHEET 21 OF 22																														
	e) Surface finish f) Thickness of joints g) Details at edges, junctions etc. h) Performance i) Precautions specified for durability 4.00.00 I.S. CODES All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table> <tr> <td>IS: 777</td> <td>:</td> <td>Glazed earthenware tiles</td> </tr> <tr> <td>IS: 1196</td> <td>:</td> <td>Code of practice for laying bitumen mastic flooring.</td> </tr> <tr> <td>IS: 1197</td> <td>:</td> <td>Code of practice for laying of rubber floors</td> </tr> <tr> <td>IS: 1237</td> <td>:</td> <td>Cement concrete flooring tiles</td> </tr> <tr> <td>IS: 1443</td> <td>:</td> <td>Code of practice for laying and finishing of cement concrete flooring tiles.</td> </tr> <tr> <td>IS: 2114</td> <td>:</td> <td>Code of practice for laying in situ terrazzo floor.</td> </tr> <tr> <td>IS: 3461</td> <td>:</td> <td>PVC asbestos floor tiles</td> </tr> <tr> <td>IS: 4860</td> <td>:</td> <td>Specification for acid resistant bricks</td> </tr> <tr> <td>IS: 5518</td> <td>:</td> <td>Code of practice for laying of flexible PVC Sheet and tile flooring.</td> </tr> <tr> <td>IS: 5491</td> <td>:</td> <td>Code of practice for laying in situ granolithic floor topping.</td> </tr> </table>	IS: 777	:	Glazed earthenware tiles	IS: 1196	:	Code of practice for laying bitumen mastic flooring.	IS: 1197	:	Code of practice for laying of rubber floors	IS: 1237	:	Cement concrete flooring tiles	IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.	IS: 2114	:	Code of practice for laying in situ terrazzo floor.	IS: 3461	:	PVC asbestos floor tiles	IS: 4860	:	Specification for acid resistant bricks	IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.	IS: 5491	:	Code of practice for laying in situ granolithic floor topping.	
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TITLE:

**TECHNICAL SPECIFICATION FOR
FLOOR FINISH AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-999-600-C012

VOLUME - II B

SECTION - D | SUB-SECTION – D12

REV.NO. 00 DATE 03/10/2017

SHEET 22 OF 22

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, Ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.



TITLE:

**TECHNICAL SPECIFICATION FOR
SHEET WORK IN ROOF AND
SIDING**

SPECIFICATION NO. PE-TS-999-600-C013

VOLUME - II B

SECTION - D | SUB-SECTION – D13

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-999-600-C013



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



TITLE:

**TECHNICAL SPECIFICATION FOR
SHEET WORK IN ROOF AND
SIDING**

SPECIFICATION NO. PE-TS-999-600-C013

VOLUME - II B

SECTION - D | SUB-SECTION – D13

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	6

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 03/10/2017 SHEET 4 OF 6
2.02.03	Fibre Glass Reinforced Plastic Sheeting This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.	
2.02.04	PERMANENT COLOUR COATED (SANDWICHED INSULATED)	
	METAL CLADDING SYSTEM	
	i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF₂) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns. ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm. iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability. iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap. v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cum. for glass wool & 48 Kg/cum. for rock wool.	

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C013
	TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	VOLUME - II B
		SECTION - D SUB-SECTION – D13
		REV.NO. 00 DATE 03/10/2017
		SHEET 5 OF 6

2.02.05

PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF₂ paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00

ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00

I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 : Code of practice for laying of asbestos cement sheets.

IS: 2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

	TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-999-600-C013 VOLUME - II B SECTION - D SUB-SECTION – D13 REV.NO. 00 DATE 03/10/2017 SHEET 6 OF 6
	IS: 1626 : Specification for asbestos cement building pipes, gutters and fittings. IS: 277 : Specification for galvanized steel sheets (plain and corrugated). 5.00.00 RATES AND MEASUREMENT 5.01.00 Rates Rates shall be unit rate for complete item described in “Schedule of Items” and shall include all wastage. 5.02.00 Measurement Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.	



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014



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



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6



TITLE:

TECHNICAL SPECIFICATION FOR SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION - D14

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 6

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the “Schedule of items”. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

- a) Plaster of Paris board (decorative)
- b) Expanded polystyrene insulation board with plastic fascia.
- c) Fibre Insulation board.
- d) Bonded wooden particle board (Plain and decorative)
- e) Glass fibre reinforced polystyrene sheets.
- f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer’s instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be “Luxalon 84C” or approved equal and the installation shall be strictly as per manufacturer’s instruction/ specification subject to approval of the Engineer.



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 6

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia. galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length: each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-ordinated with all related work and shall show the following information:

- a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.
- b) Typical Intermediate framing for support where required.
- c) Hanger fastening details.
- d) Panels - unit support at ceiling penetrations.
- e) Details of splicing method for main and cross runners.
- f) A table indicating load bearing capacity of main and cross runner
- g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.



TITLE:

**TECHNICAL SPECIFICATION FOR
SUSPENDED CEILING**

SPECIFICATION NO. PE-TS-999-600-C014

VOLUME - II B

SECTION - D | SUB-SECTION – D14

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 6

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the “Schedule of Items”. No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 23

VOLUME: II B

SECTION - D

SUB-SECTION – D15

**WATER SUPPLY, DRAINAGE
AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015



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



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 23

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIAL	3
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	17
5.00.00	I.S. CODES	20
6.00.00	RATE AND MEASUREMENT	21



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 23

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade conforming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 23

For Roof drainage and building sanitation works following type of pipe are coved in this Section:

- a) Cast Iron pipe
- b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)
- c) Concrete pipe
- d) Asbestos cement pipe
- e) PVC pipe
- f) Stoneware pipe
- g) Vitrified pipe
- h) Lead pipe (not to be used for portable water)

2.02.01

Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 23

Water closet

a) European type

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) Squatting type

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, Part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 23

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Glass shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00

Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 7 OF 23

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 23

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 9 OF 23

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 10 OF 23

have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified, the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia.	:	1 in 35
150 mm nominal dia.	:	1 in 65
230 mm nominal dia.	:	1 in 120
300 mm nominal dia.	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 11 OF 23

done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

- a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
- b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.
- c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.
- d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05

Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 12 OF 23

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 13 OF 23

3.04.10

Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 14 OF 23

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement: 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 15 OF 23

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earth ware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 16 OF 23

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leak-proof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 17 OF 23

pipe of at least 100 mm dia. whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open jointed SW Pipe/dispersion trenches

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 18 OF 23

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 19 OF 23

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION - D15

REV.NO. 00 DATE 03/10/2017

SHEET 20 OF 23

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt. XVI)	:	Laying of water and sewer lines, including appurtenant items.

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015
		VOLUME - II B
		SECTION - D SUB-SECTION – D15
		REV.NO. 00 DATE 03/10/2017
		SHEET 21 OF 23
	IS: 1230 : Cast iron rain water pipes and fittings. IS: 1239 : Specification for Mild Steel Tubes and Mild Steel (Pt. I & III) Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter). IS: 1536 : Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage. IS: 1537 : Specification for vertically cast iron pressure pipes for water, gas and sewage. IS: 1592 : Asbestos cement pressure pipes, IS: 1626 : Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types). IS: 2065 : Code of Practice for Water Supply in buildings. IS: 2501 : Copper tubes for general engineering purposes. IS: 2556 : Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement IS: 2633 : Method of testing, uniformity of coating on zinc coated articles. IS: 3076 : Low density polyethylene pipes for portable water supplies. IS: 3486 : Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter). IS: 3589 : Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter). IS: 4827 : Specification for electro plated coatings of nickel and chromium on copper and copper alloy. IS: 4964 : High-density polyethylene pipes for portable water supplies. IS: 12701 : Rotational moulded polyethylene water storage tanks	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	SPECIFICATION NO. PE-TS-999-600-C015 VOLUME - II B SECTION - D SUB-SECTION – D15 REV.NO. 00 DATE 03/10/2017 SHEET 22 OF 23
6.00.00	RATE AND MEASUREMENT	
6.01.00	RATE	
6.01.01	G.I. Pipes for Water Supply	
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.	
6.01.02	Rainwater Down-comers	
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also includes cost of jointing and making good the opening in structure.	
6.01.03	Sanitary Fixtures	
	Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of “Schedule of Items”. Rate shall also include the jointing of waste & traps to drain pipes.	
6.01.04	Drainage and Sewer Pipes	
	Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.	
6.01.05	Floor and Gully Traps	
	Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in “Schedule of Items”.	
6.01.06	Manholes, Septic Tank, Soak Pit and Cover	
	Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.	
6.01.07	Water Storage Tank	
	The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.	



TITLE:

**TECHNICAL SPECIFICATION
FOR WATER SUPPLY,
DRAINAGE AND SANITATION**

SPECIFICATION NO. PE-TS-999-600-C015

VOLUME - II B

SECTION - D | SUB-SECTION – D15

REV.NO. 00 DATE 03/10/2017

SHEET 23 OF 23

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I. Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 36

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 36

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	36
5.00.00	MEASUREMENT	36



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 36

**Standard Technical Specification
For Road and Drainage**

1.00.00 Scope

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

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

1.01.00 Works to Be Provided by The Contractor

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

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc. all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc.) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work to Be Provided by Others

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

1.03.00 Conformity with Designs

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

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 4 OF 36
1.04.00	Materials to Be Used All materials required for the work shall be the best commercial variety and as approved by the engineer. 2.00.00	Codes and Standards All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise. a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC b) IRC: 19 - Standard specification and code of practice for Water bound Macadam c) IRC: SP 11 - Hand Book of Quality Control for Construction of Roads and Runways d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete. e) IS:2212 - Code of Practice for Brick work f) IS: 783 - Code of Practice for Laying of Concrete Pipes g) IS: 1201 - Methods of testing tar and bituminous materials to 1220 h) IS: 73 - Specification for paving bitumen i) IS: 215 - Specification for Road tar j) IS: 216 - Coal tar pitch k) IS: 217 - Specification for cut-back bitumen l) IS: 454 - Specification for cut-back bitumen from waxy crude m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non-extruding and resilient type Part I Bitumen impregnated fibre



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 36

Part II CNSL Aldehyde resin and coconut pith

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

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

2.01.00

Quality Control

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

a) Horizontal Alignment

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

b) Longitudinal Profile

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

Sub-grade $\pm 25\text{ mm}$
Sub-base $\pm 20\text{ mm}$
Base course $\pm 15\text{ mm}$
Wearing course $\pm 10\text{ mm}$



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 36

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

c) Surface Regularity of Sub-grade and Pavement Courses

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

TABLE -I

**PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT
COURSES**

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

 Maharatna Company	TITLE:		SPECIFICATION NO. PE-TS-999-600-C016				
	TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE		VOLUME - II B				
			SECTION - D		SUB-SECTION – D16		
			REV.NO.	00	DATE	03/10/2017	
		SHEET	7	OF	36		
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

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

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

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

3.00.00 Execution

3.01.00 Setting Out

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 8 OF 36

3.02.00 Clearing and Grubbing

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

3.03.00 Filling in Embankment

3.03.01 General

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 9 OF 36

Table - II

Density Requirements of Embankment Materials

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

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

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

3.03.02 Setting Out

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 10 OF 36

3.03.03 Stripping and Storing top soil

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

3.03.04 Compacting Original Ground

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

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 11 OF 36

be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06

Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials. Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 12 OF 36

Table - III

Compaction Requirements for Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS: 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing with Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 13 OF 36

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc. and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 14 OF 36
	3.04.05 Top Dressing After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water. 3.04.06 Watering and Maintenance The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance. 3.05.00 Shoulder Construction 3.05.01 Description This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer. 3.05.02 Materials Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards. 3.05.03 Construction Operations Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer. In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted. Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the	

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 15 OF 36
	pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required cross fall shall be maintained to drain off surface water. 3.06.00 Kerb 3.06.01 Material Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level. 3.06.02 Laying The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm. The gap shall be filled with cement mortar as specified. The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer. 3.07.00 Sub-base (Granular Sub-base) 3.07.01 Description This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer. 3.07.02 Materials The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 16 OF 36

**Table - IV
Grading for Granular Sub-Base Material**

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note: The materials passing 425micron sieve for all the three gradings when tested according to IS: 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS: 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS: 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation's and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 17 OF 36

Moisture content of the loose material shall be checked in accordance with IS: 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS: 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 18 OF 36

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

S.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS: 2386 (Part IV) IS: 2386 (Part IV) or IS: 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value b) Flakiness Index ***	IS: 2386 (Part IV) IS: 2386 (Part IV) or IS: 5640 ** IS: 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS: 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However, the use of Grading-1 shall be restricted to sub-base courses only.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 19 OF 36

**Table - VI
Grading Requirements of Coarse Aggregates**

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75-micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 20 OF 36

**Table - VII
Grading for Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm	100
		10.0 mm	90 - 100
		4.75 mm	10 - 30
		150 micron	0 - 8
B	10 mm	10 mm	100
		4.75 mm	85 - 100
		150 micron	10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS: 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the center line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 21 OF 36

done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 22 OF 36

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 23 OF 36
	3.09.00 Tack Coat 3.09.01 Description The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction. 3.09.02 Materials The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback. 3.09.03 Construction Operations a) Preparation of Base The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder. b) Application of Binder Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction. 3.10.00 Bituminous Macadam Binder Course 3.10.01 Description This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.	



TITLE:

TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 24 OF 36

3.10.02

Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS: 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates for Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS: 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS: 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS: 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS: 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS: 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 25 OF 36

Table-IX

Aggregates Grading for 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X

Aggregates Grading for 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 - 100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 26 OF 36

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportion of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03

Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self-propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 27 OF 36

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tons' power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the center longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 28 OF 36
	surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it. The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it. 3.11.00 Open Graded Premix Carpet 3.11.01 Description This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification. 3.11.02 Materials a) Binder The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable. b) Aggregates The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30. c) Proportioning of Materials The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 29 OF 36

Table - XI

Quantity of Materials Required for 10 Sq. M of Road Surface for 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet

i)	Stone Chippings - 12mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
Total		0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0.18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
Total		14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 30 OF 36

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However, application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material is laid, rolling shall be commenced with 6 to 8 tons' power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted

	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 31 OF 36
	with a thin surface coat of approved binder before the new mix is placed against it. f) Seal Coat A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed. 3.12.00 Seal Coat 3.12.01 Description This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber. <u>Type-A:</u> Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings. <u>Type-B:</u> Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder. 3.12.02 Materials a) Binder The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS: 73, 217 or 454 as applicable or any other approved cutback. The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively. b) Stone Chippings for Type a Seal Coat The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m. per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 32 OF 36

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180-micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03

Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 33 OF 36

binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However, in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc. or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-999-600-C016 VOLUME - II B SECTION - D SUB-SECTION – D16 REV.NO. 00 DATE 03/10/2017 SHEET 34 OF 36
	on approved drawing, drains shall be of R.C.C. construction with necessary slopes. 3.15.00 Culverts Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the “Specification for Earthwork in Excavation and Backfilling”, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable. 3.16.00 Pipe Culverts and Drainage Pipes 3.16.01 Materials The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS: 458 and shall be procured from approved manufacturers with collars as per manufacturer’s specification. The tenderer shall specifically mention the particular manufacturer’s product he proposes to use. Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383. 3.16.02 Laying of Pipes Laying of concrete pipes shall correspond to IS:783 and as per the specification given below. a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc. as required shall be done by the Contractor. Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per “Specification for Earthwork in Excavation and Backfilling” to the	

**TITLE:****TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION - D16

REV.NO. 00 DATE 03/10/2017

SHEET 35 OF 36

satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS: 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc. as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-999-600-C016

VOLUME - II B

SECTION - D | SUB-SECTION – D16

REV.NO. 00 DATE 03/10/2017

SHEET 36 OF 36

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS: 783.

3.16.03 Relation with Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.



TITLE:

**TECHNICAL SPECIFICATION FOR
FABRICATION OF STRUCTURAL
STEEL WORK**

SPECIFICATION NO. PE-TS-999-600-C017

VOLUME - II B

SECTION - D

SUBSECTION -D17

REV.NO. 0

DATE 03/10/2017

SHEET 1

OF 41

VOLUME: II B

SECTION - D (PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK



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



TITLE:

**TECHNICAL SPECIFICATION FOR
FABRICATION OF STRUCTURAL
STEEL WORK**

SPECIFICATION NO. PE-TS-999-600-C017

VOLUME - II B

SECTION - D SUBSECTION -D17

REV.NO. 0 DATE 03/10/2017

SHEET 2 OF 41

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	WORKMANSHIP	19
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	29
5.00.00	INFORMATION TO BE SUBMITTED	33
6.00.00	RATES AND MEASUREMENTS	34

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 3 OF 41
SUB-SECTION – D XVII FABRICATION OF STRUCTURAL STEEL WORK 1.00.00 SCOPE This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract. 2.00.00 GENERAL 2.01.00 Work to be provided for by the Contractor The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval. b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made. c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings. d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections, e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification. f) Suitably mark, bundle, and pack for transport all fabricated materials. g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork. h) Insure, load and transport all fabricated steelwork field connection materials to site.		

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 4 OF 41
	i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract. 2.02.00 Work by others No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract. 2.03.00 Codes and standards All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed: IS: 226 - Structural steel (Standard Quality) IS: 800 - Code of Practice for general construction in steel. IS: 806 - Code of practice for use of steel tubes in general building construction. IS: 808 - Rolled steel beams, channels, and angle sections IS: 813 - Scheme of symbols for welding IS: 814 - Covered electrodes for metal arc welding of structural steel IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels. IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel IS: 817 - Code of practice for training and testing metal arc welders IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations IS: 822 - Code of practice for inspection of welds IS: 919 - Recommendations for limits and fits for Engineering	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	03/10/2017
		SHEET	5	OF	41
IS: 961 - Structural Steel (High Tensile) IS: 1148 - Rivet bars for structural purposes IS: 1149 - High tensile rivet bars for structural purposes IS: 1161 - Steel Tubes for structural purposes IS: 1200 - Method of measurement of steelwork and ironwork (Part 8) IS: 1239 - Mild Steel Tubes IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm) IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and 1 locknuts (Dia, range 6 to 39 mm) IS: 1367 - Technical supply conditions for threaded fasteners IS: 1442 - Covered electrodes for the metal are welding of high tensile structural steel IS: 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes. IS: 1731 - Dimensions for steel flats for structural and general engineering purposes IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products IS: 1977 - Structural steel (ordinary quality) St-42-0 IS: 2062 - Steel for General Structural Purposes IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming IS: 2595 - Code of Practice for Radiographic Testing IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles					

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	03/10/2017
		SHEET	6	OF	41
		IS: 3757 - High strength structural bolts IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products IS: 7205 - Safety Code for Erection of Structural Steelwork IS: 7215 - Tolerances for fabrication of steel structures IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels. IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.			
2.04.00	Conformity with Designs The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.				
2.05.00	Materials to be used				
2.05.01	General All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section. The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and				

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 7 OF 41
amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.		
2.05.02	Steel	All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable: a) IS: 2062 - Steel for general structural purposes b) IS: 961 - Structural steel High Tensile c) IS: 1977 - Structural steel (Ordinary quality) St-42-0 In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.
2.05.03	Rivet Steel	All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable: a) IS: 1148 - Rivet Bars for structural purpose b) IS: 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.
2.05.04	Electrodes	All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable a) IS: 814 - Covered electrodes for metal arc welding of structural steel b) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel c) IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 8 OF 41
	d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels 2.05.05 Bolts and Nuts All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners. Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable. a) Mild Steel All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 $\sqrt{A}$, where "A" is the cross sectional area of the test specimen i) IS: 1367: Technical supply conditions for threaded fasteners ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube b) High Tensile Steel The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer. 2.05.06 Washers Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract: a) IS: 2062 - Steel for general structural purposes b) IS: 961 - Structural Steel (High Tensile Quality) c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0 d) IS: 6649 - Hardened washers	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 9 OF 41
2.05.07	Paints Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready Mixed Paint, Red oxide Zinc Chromate Priming.	
2.06.00	Coal Bin	
2.06.01	Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have been conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.	
2.06.02	For general requirements, fabrication and construction details IS: 9178 (Pt. I & II) shall be followed as general guidance. The bins shall be fabricated and erected in segments.	
2.06.03	The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.	
2.06.04	Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.	
2.06.05	Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.	
2.07.00	New Erection Marks	
2.07.01	Additional structures involving new erection marks may be required to be added at any stage of work.	
2.07.02	All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.	
2.07.03	All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	03/10/2017
		SHEET	10	OF	41

2.08.00	ELECTRO FORGED STEEL GRATINGS
2.08.01	Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.
2.08.02	All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.
2.08.03	The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.
2.08.04	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.
2.08.05	Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.
2.08.06	The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.
2.08.07	Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.
2.08.08	Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.
2.08.09	Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 12 OF 41																					
	the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection. 2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633. 2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose. 2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection. 2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains. 2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner. 2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item) 2.10.01 Material In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed. Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used. <table> <thead> <tr> <th>Material</th><th>%</th><th>Remarks</th></tr> </thead> <tbody> <tr> <td>Carbon</td><td>10.03%</td><td>Max.</td></tr> <tr> <td>Silicon</td><td>1.60%</td><td>Max.</td></tr> <tr> <td>Manganese</td><td>0.80% to 1.50%</td><td></td></tr> <tr> <td>Phosphorous</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Sulphur</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Chromium</td><td>10.80% to 12.50%</td><td></td></tr> </tbody> </table>	Material	%	Remarks	Carbon	10.03%	Max.	Silicon	1.60%	Max.	Manganese	0.80% to 1.50%		Phosphorous	0.03%	Max.	Sulphur	0.03%	Max.	Chromium	10.80% to 12.50%		
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 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017																								
		VOLUME - II B																								
		SECTION - D SUBSECTION -D17																								
		REV.NO. 0 DATE 03/10/2017																								
		SHEET 13 OF 41																								
	<table> <tr> <td>Nickel</td> <td>1.50%</td> <td>Max.</td> </tr> <tr> <td>Titanium</td> <td>0.75%</td> <td>Max.</td> </tr> <tr> <td>Nitrogen</td> <td>0.03%</td> <td>Max.</td> </tr> </table> The mechanical properties shall be as follows: <table> <tr> <th>Description</th> <th>Value</th> <th>Remarks</th> </tr> <tr> <td>Hardness Rock Well B Scale</td> <td>90</td> <td>Max.</td> </tr> <tr> <td>Tensile Strength</td> <td>450 MPa</td> <td>Min.</td> </tr> <tr> <td>Yield Strength</td> <td>300 MPa</td> <td>Min.</td> </tr> <tr> <td>Elongation</td> <td>25%</td> <td>Min.</td> </tr> </table>	Nickel	1.50%	Max.	Titanium	0.75%	Max.	Nitrogen	0.03%	Max.	Description	Value	Remarks	Hardness Rock Well B Scale	90	Max.	Tensile Strength	450 MPa	Min.	Yield Strength	300 MPa	Min.	Elongation	25%	Min.	
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2.10.02	Fabrication The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.																									
2.10.03	Fabrication Drawings a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly, the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also require adjustment in the size of each element of hopper plate and also additional weld joints. b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store																									

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 14 OF 41
	will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store. c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above. 2.10.04 Cuffing Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded. 2.10.05 Jointing Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test. 2.10.06 Bending The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile. 2.10.07 Welding sequence The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer. 2.10.08 Acceptance Criteria of Fabricated Structures The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 15 OF 41
	results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215. 2.11.00 BEARINGS 2.11.01 PTFE (Poly tetra fluorethylene) slide bearing a) General The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm. b) Material PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm. The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm². c) Installation The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 16 OF 41
	beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed. 2.12.00 Storage of material 2.12.01 General All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks. 2.12.02 Steel The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather. 2.12.03 Electrodes The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating. 2.12.04 Bolts, Nuts and Washers Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality. 2.12.05 Paints Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 17 OF 41
2.13.00	Quality Control The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor. Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work. The quality control procedure shall cover but not be limited to the following items of work a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used. b) Rivets, Bolts, : Manufacturer's certificate, dimension checks, Nuts & Washers material testing. c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating. d) Welders : Qualifying Tests e) Welding sets : Performance Tests f) Welds : Inspection, X-ray, Ultrasonic tests g) Paints : Manufacturer's certificate, physical inspection reports h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 18 OF 41
2.14.00	Standard dimensions, forms and weights The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.	
2.15.00	Fabrication Drawings The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval. The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents. The fabrication drawings shall include but not limited to the following: - Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections. - Dimensional drawings of base plates, foundation bolts location etc. - Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings. - Complete Bill of Materials and detailed drawings of all sections as also their billing weights. - Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof. These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 19 OF 41
	necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length. The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract. 3.00.00 WORKMANSHIP 3.01.00 Fabrication 3.01.01 General All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent. 3.01.02 Straightening Material Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C. 3.01.03 Cutting Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 20 OF 41
	expert hand, subject to the approval of the Engineer. To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion. 3.01.04 Planning of edges Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer. 3.01.05 Clearances The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided. 3.02.00 Riveted and bolted construction 3.02.01 Holes Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them. Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 21 OF 41
3.02.02	specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly. Holes for rivets or bolts shall not be formed by gas cutting process. Assembly All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained. Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C. Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required. Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole. All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 22 OF 41
	section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary. Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer. Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings. 3.03.00 Welded Construction 3.03.01 General Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817. 3.03.02 Preparation of material Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch. 3.03.03 Assembling Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°). The work shall be positioned for flat welding whenever practicable.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 23 OF 41
3.03.04	Welding Sequence In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements. In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer. 3.03.05 Welding technique All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness. Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract. To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards. 3.03.12 Temperature No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 24 OF 41
	precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard. 3.03. 13 Peening Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening. 3.03. 14 Equipment These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer. 3.04.00 Finish Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm. 3.05.00 Slab bases and caps Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	03/10/2017
		SHEET	25	OF	41

3.12.00

Lacing bars

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

3.13.00

Separators

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

3.14.00

Bearing Plates

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

3.15.00

Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively, diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00

Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 26 OF 41
3.11.00	Architectural Clearances Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances. 3.11.00 Shop connections a) All shop connections shall be otherwise riveted or welded as specified on the Drawings. b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection. c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer. 3.13.00 Castings Steel castings shall be annealed. 3.14.00 Shop erection The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 27 OF 41
3.15.00	Shop painting	
3.15.01	General	
	Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.	
	After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.	
3.15.02	Inaccessible parts	
	Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.	
3.15.03	Contact surfaces	
	Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.	
3.15.04	Finished surfaces	
	Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.	
3.15.05	Surfaces adjacent to field welds	
	Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 29 OF 41
	not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer. 4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY 4.01.00 Inspection Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification. The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification. 4.02.00 Testing and Acceptance Criteria 4.02.01 General The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test. 4.02.02 Steel All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor. All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 30 OF 41
4.02.02	Welding a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc. b) Non-destructive examination shall be carried out to determine soundness of weldments as follows: i) 10% at random on fillet-joints. ii) 100% on all butt-joints. c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs. d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.	
4.02.04	Rivets, bolts, nuts and washers All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.	
4.02.05	Shop painting All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 31 OF 41
	4.02.12 Galvanizing All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products. 4.03.00 Tolerance The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures. 4.04.00 Acceptance Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost. When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract. 4.05.00 Delivery of materials 4.05.01 General The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 32 OF 41
	4.05.02 Marking Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection. 4.05.03 Shipping Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit. Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following: a) Name and address of the consignee b) Name and address of the consignor c) Gross weight of the package in tonnes and its dimensions d) Identification marks and/or number of the package e) Custom registration number, if required All markings shall be carried out with such materials as would ensure quick drying and indelibility. Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers. Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially - a) Name of the Contractor b) Number and date of the Contract c) Name of the office placing the contract d) Nomenclature of stores	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 33 OF 41
	e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each. The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads. After delivery of the materials at site, all packing materials shall automatically become the property of the Owner. Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor. The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges. If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor. Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance. 5.00.00 INFORMATION TO BE SUBMITTED 5.01.00 With Tender The following information is required to be submitted with the Tender: a) Progress Schedule The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work. i) Preparation and approval of fabrication drawing ii) Procurement of Materials iii) Fabrication and shipping of all anchor bolts iv) Fabrication and shipping of main steelwork.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 34 OF 41
	v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable. vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork. vii) Final date of completion of all shipments. b) Shop Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted. 5.02.00 After Award After award of the Contract the successful Tenderer is to submit the following: a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule. b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information. c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials. d) Results of any test as and when conducted and as require by the engineer. e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017			
		VOLUME - II B			
		SECTION - D		SUBSECTION -D17	
		REV.NO.	0	DATE	03/10/2017
		SHEET	35	OF	41

6.00.00	RATES AND MEASUREMENT
6.01.00	Rates
6.01.01	The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.
6.01.02	The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.
6.01.03	The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.
6.01.04	No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.
6.01.05	Rates shall be inclusive of all leads and lifts/elevation.
6.01.06	The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces'/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 36 OF 41
	The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site. Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ. 6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC. 6.01.08 The bidder's rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified. 6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint. 6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint. 6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration. 6.01.12 The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification. 6.01.13 The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.	

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 37 OF 41
	6.01.14 The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unutilized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member. The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/contract specifications. 6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight. 6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc. 6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces'/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 39 OF 41
	from assumed minimum circumscribing rectangular area for the purpose of payment. 6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m. 6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment. 6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment. 6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting. 6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds. 6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units. 6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 40 OF 41
	6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below 6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured. 6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark. 6.02.21 For re-erection the weight of the modified erection mark shall only be measured. 6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel. 6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings. 6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate. 6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.	

	TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-999-600-C017 VOLUME - II B SECTION - D SUBSECTION -D17 REV.NO. 0 DATE 03/10/2017 SHEET 41 OF 41
6.02.26	The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION – D18

REV.NO. 0 DATE 03/10/2017

SHEET 1 OF 17

VOLUME: II B

**SECTION - D
(PART I)**

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION – D18

REV.NO. 0 DATE 03/10/2017

SHEET 2 OF 17

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	WORKMANSHIP	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	12
5.00.00	INFORMATION TO BE SUBMITTED	16

	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 03/10/2017 SHEET 3 OF 17
SUB-SECTION – D 18 ERECTION OF STRUCTURAL STEELWORK 1.00.00 SCOPE This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract. 2.00.00 GENERAL 2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following: a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork. b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part. c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures. d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks. e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer. f) Painting of the erected steel structures.		



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 4 OF 17

- g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:
- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size rivet or bolt if required.
 - iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
 - v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
 - vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
 - vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

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

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions of the Engineer.

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018			
		VOLUME - II B			
		SECTION - D		SUBSECTION – D18	
		REV.NO.	0	DATE	03/10/2017
		SHEET	5	OF	17

2.05.00

Material

2.05.01

General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02

Materials to conform to Indian standards

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

2.06.00

Storage of Materials

2.06.01

General

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

2.06.02

Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C018	
	TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	VOLUME - II B	
		SECTION - D	SUBSECTION – D18
		REV.NO. 0	DATE 03/10/2017
		SHEET 6	OF 17

2.06.03

Covered Store

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

2.07.00

Quality Control

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

i)

Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii)

Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii)

Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00

Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00

WORKMANSHIP

3.01.00

Erection

3.01.01

Plant and Equipment

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



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 7 OF 17

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

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

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

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

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

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

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 8 OF 17

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

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

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

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

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

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

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 9 OF 17

there shall be no rotation of the part not turned by the wrench.

TABLE-I

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

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

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

b) Torque Wrench Tightening

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

TABLE-II

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

	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 03/10/2017 SHEET 10 OF 17
	Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench. In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause. 3.01.08 Field Welding All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints. 3.01.09 Holes, Cutting and Fitting No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer. The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work. 3.02.00 Drifting Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge	

 BHEL Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 03/10/2017 SHEET 11 OF 17
3.03.00	holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed. Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited. Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced) Grouting shall be carried out with Ordinary Cement grout as described below: The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings. No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position. Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned. If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.	
3.04.00	Painting after Erection Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance	

	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 03/10/2017 SHEET 12 OF 17
	with the requirements of the specification for fabrication of structural steelwork applicable for the project. Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust. All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet. Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted. The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved “Schedule of Painting”. The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932. 3.05.00 Final cleaning up Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work. 4.00.00 TESTING AND ACCEPTANCE CRITERIA 4.01.00 General Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable	

	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018 VOLUME - II B SECTION - D SUBSECTION – D18 REV.NO. 0 DATE 03/10/2017 SHEET 13 OF 17
	and appropriate time extensions will be allowed. The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer. 4.01.01 Stiffness Test In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test. 4.01.02 Strength Test The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours. In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load. 4.01.03 Structure of same design Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.	



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 14 OF 17

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

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	TITLE: TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	SPECIFICATION NO. PE-TS-999-600-C018
		VOLUME - II B
		SECTION - D SUBSECTION – D18
		REV.NO. 0 DATE 03/10/2017
		SHEET 15 OF 17
	other member connection levels: i) For a column upto and including 10M height ii) For a column greater than 10M but less than 40M height c) For adjacent pairs of columns across the width of the building prior to placing of truss d) For any individual column deviation of any bearing or resting level from levels shown on drawings. e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating Trusses least. Trusses Crane Cirders	i) ± 3.5 mm from true vertical ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ± 7 mm per 30m length. ± 9.0 mm on true span. ± 3.0 mm 3.0 mm 1/1500 of the span or greater than 10mm whichever is the centre of bottom chord. 1/250 of depth of truss or 20 mm which ever is the - least. 2.0 mm. ± 3.0 mm



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 03/10/2017

SHEET 16 OF 17

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

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

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

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

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

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

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



TITLE:

TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK

SPECIFICATION NO. PE-TS-999-600-C018

VOLUME - II B

SECTION - D SUBSECTION – D18

REV.NO. 0 DATE 03/10/2017

SHEET 17 OF 17

5.01.02

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

5.01.03

Erection Yard

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

5.02.00

After award of the Contract

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

5.02.01

Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02

Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.



TITLE:

**TECHNICAL SPECIFICATION FOR
ROOF DECKING**

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION – D19

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 7

VOLUME: II B

SECTION - D

SUB-SECTION – D19

ROOF DECKING

SPECIFICATION NO. PE-TS-999-600-C019



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ROOF DECKING**

SPECIFICATION NO. PE-TS-999-600-C019

VOLUME - II B

SECTION - D | SUB-SECTION – D19

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 7

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	3
4.00.00	ACCEPTANCE CRITERIA	6
5.00.00	IS CODES	6
6.00.00	RATES AND MEASUREMENTS	7

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 03/10/2017 SHEET 3 OF 7
<u>ROOF DECKING</u> 1.00.00 Scope This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings. 2.00.00 Material 2.01.01 Roof of main plant TG and Deaerator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and center to center of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins. 3.00.00 INSTALLATION The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein. The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work. 3.01.00 Detailed Design of Roof Decking The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.		

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 03/10/2017 SHEET 4 OF 7
	The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained. 3.02.00 Erection & Fixing 3.02.01 Sequence of Manufacture/Erection Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps. 3.02.02 Position and Location of Laps Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind. The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof. 3.02.03 Alignment of Sheets and Fixings All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds. 3.02.04 Site Cutting Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps. 3.02.05 Damaged Sheets Distorted, blemished or water stained sheets and any other fittings shall not be used.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 03/10/2017 SHEET 5 OF 7
	3.02.06 Laps End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm. 3.02.07 End Lap Fixings End lap fixings shall be located at least 25 mm from the end of each sheet. 3.02.08 Side Lap Fixings The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation. 3.02.09 Holes Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc. 3.02.10 Location and Spacing of Fixings Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins. 3.02.11 Fixings The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self-drilling / self-tapping screws of minimum thread diameter of 5.6mm. These self-drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 03/10/2017 SHEET 6 OF 7
	recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets. 3.03.00 Protection during Construction Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times. 3.04.00 Damage Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner. 4.00.00 Acceptance Criteria The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked: a) Side and end laps b) Absence of damage in the sheeting. c) Conformity of fixings with the approved design. 5.00.00 IS Codes All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. IS: 513- Specification for cold rolled carbon steel sheets. IS: 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion. IS: 4431 - Specification for carbon & carbon manganese free cutting steel. IS: 1573 - Electroplated Coatings of zinc on iron and steel.	

 BHEL Bharat Heavy Electricals Limited	TITLE: TECHNICAL SPECIFICATION FOR ROOF DECKING	SPECIFICATION NO. PE-TS-999-600-C019 VOLUME - II B SECTION - D SUB-SECTION – D19 REV.NO. 00 DATE 03/10/2017 SHEET 7 OF 7
6.00.0 6.01.00 6.02.00	RATES AND MEASUREMENTS Rates Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage. Method of Measurement Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size. No payments shall be made for laps.	



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 6

VOLUME: II B

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

SPECIFICATION NO. PE-TS-999-600-C020



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



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 6

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	MATERIALS	3
3.00.00	INSTALLATION	4
4.00.00	ACCEPTANCE CRITERIA	5
5.00.00	IS CODES	6
6.00.00	RATES AND MEASUREMENTS	6



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION - D20

REV.NO. 00 DATE 03/10/2017

SHEET 3 OF 6

FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supplies of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of + 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of ± 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 03/10/2017

SHEET 4 OF 6

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimize dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system

	TITLE: TECHNICAL SPECIFICATION FOR FALSE FLOORING	SPECIFICATION NO. PE-TS-999-600-C020 VOLUME - II B SECTION - D SUB-SECTION – D20 REV.NO. 00 DATE 03/10/2017 SHEET 5 OF 6
	shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment. All installation work of the false flooring system shall be supervised by the manufacturer's authorized representative. 3.03.00 Painting After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint. 3.04.00 Protection during Construction All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner. 3.05.00 Damage Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner. 4.00.00 ACCEPTANCE CRITERIA The false flooring system shall only be accepted after completion of following checks: - Level - Alignment of joints - Thickness of joints - Surface finish - Colour and texture - Details of edges, junctions etc. - Performance - Criteria specified for strength.	



TITLE:

**TECHNICAL SPECIFICATION
FOR FALSE FLOORING**

SPECIFICATION NO. PE-TS-999-600-C020

VOLUME - II B

SECTION - D | SUB-SECTION – D20

REV.NO. 00 DATE 03/10/2017

SHEET 6 OF 6

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.



TITLE:

**TECHNICAL SPECIFICATION
FOR ANTI-TERMITE
TREATMENT**

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION – D23

REV.NO. 00 DATE 03/10/2017

SHEET 1 OF 5

VOLUME – II B

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023



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



TITLE:

**TECHNICAL SPECIFICATION
FOR ANTI-TERMITE
TREATMENT**

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION – D23

REV.NO. 00 DATE 03/10/2017

SHEET 2 OF 5

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	EXECUTION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	RATES	4
5.00.00	METHOD OF MEASUREMENT	4
6.00.00	I.S. CODES	5

 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-999-600-C023	
		VOLUME - II B	
		SECTION - D	SUB-SECTION – D23
		REV.NO. 00	DATE 03/10/2017
		SHEET 3	OF 5

**TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	: 1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column

	TITLE: TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-999-600-C023 VOLUME - II B SECTION - D SUB-SECTION – D23 REV.NO. 00 DATE 03/10/2017 SHEET 4 OF 5
	pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M² of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose. 2.02.02 Treatment of Top Surface of Plinth Filling Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces. 2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. 2.02.04 Treatment of Expansion Joints These shall receive special attention and shall be treated in a manner approved by the Engineer. 2.02.05 Treatment at Junction of the Wall and the Floor Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface. A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation. 3.00.00 ACCEPTANCE CRITERIA The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.	



TITLE:

TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023

VOLUME - II B

SECTION - D | SUB-SECTION – D23

REV.NO. 00 DATE 03/10/2017

SHEET 5 OF 5

4.00.00 RATES

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, buried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00	I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.



TITLE:

QUALITY ASSURANCE TESTS AND
INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024

VOLUME - IIB

SECTION - D

SUB SECTION- D24

REV. 0

DATE 03/10/2017

SHEET 1 of 6

VOLUME: II B

SECTION – D

SUB SECTION – D24

QUALITY ASSURANCE TESTS AND INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024



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



TITLE:

QUALITY ASSURANCE TESTS AND INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024

VOLUME - IIB

SECTION - D

SUB SECTION- D24

REV. 0

DATE 03/10/2017

SHEET 2 of 6

QUALITY ASSURANCE TESTS AND INSPECTION

CIVIL & STRUCTURAL WORKS

Remarks/Frequency of Test		* For Test at S.No. 1, 2, 6 & 7 frequency of test shall be one in every 2000 M³ for each type & source of fill material. # Frequency of test for Sr. No. 3, 4 & 5 shall be one in every 5000 M³ for each type & source of fill material. @ For foundation filling, one for every 10 foundations for each compacted layer. However for heavily loaded foundations, each layer shall be tested. For area filling, one for every 1000 M² area for each compacted Layer. Note: The contractor shall include provision for setting up testing laboratory with all apparatus and equipments necessary for carrying out field tests.
All tests as per Indian/International STDS	11	Y Y
Dry Density by Proctor Needle Penetration @	10	- Y
Relative Density Index @	9	- Y
Dry Density by core cutter/sand display cut @	8	- Y
Moisture Content *	7	Y -
STD Proctor Test *	6	Y -
Chemical Analysis #	5	Y -
Free Swell Index #	4	Y -
Shrinkage Limit #	3	Y -
Liquid Limit & Plastic Limit *	2	Y -
Grain Size Analysis *	1	Y -
Test Requirements		
Item/Components		
1. EARTH WORK		
a) Earth Fill Material (Before Compaction)		
b) Earth Fill Material (After Compaction)		



TITLE:

QUALITY ASSURANCE TESTS AND INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024

VOLUME - IIB

SECTION - D

SUB SECTION- D24

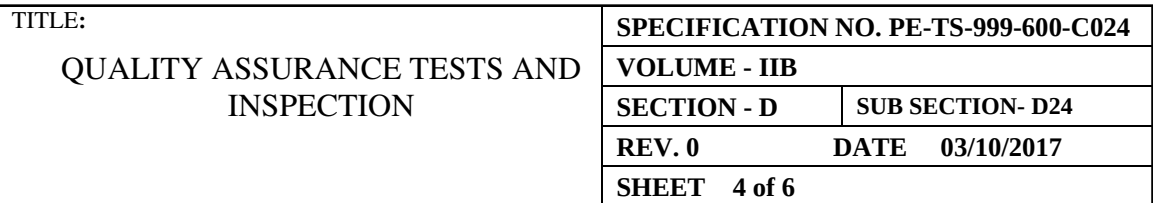
REV. 0

DATE 03/10/2017

SHEET 3 of 6

CIVIL & STRUCTURAL WORKS

CIVIL & STRUCTURAL WORKS						
Remarks/Frequency of Test		* Quantum of check for test at Sr. No 1 & 2 shall be one per 100 m ³ or part thereof or change of source whichever is earlier.	# To be done every day before start of work.	Note: For test at Sr. No. 3, 4, 5, 6, 7, 8, 9, 11& 12 once per source. For remaining as per IS Code.		
All tests as per IS-Codes	21	Y	Y	Y		
Rebound Hammer Test	20	-	-	Y		
Cement Content	19	-	-	Y		
W.C. Ratio	18	-	-	Y		
Slump and Compaction Factor	17	-	-	Y		
Harmful substance	16	-	-	Y		
pH Value	15	-	-	Y		
Crushing Strength	14	-	Y	Y		
Setting Time	13	-	Y	-		
Petrographic Exam.	12	Y	Y	-		
Silt, Clay and organic impurities	11	-	Y	-		
Bulkage	10	-	Y #	-		
Mortar Making Properties	9	-	Y	-		
Deleterious Matl. And MICA content	8	Y	Y	-		
Flakiness Index	7	Y	-	-		
Reaction with Alkali	6	Y	Y	-		
Soundness	5	Y	Y	-		
Mech. Properties	4	Y	-	-		
Specific Gravity, Density, Void, Absorption	3	Y	Y	-		
Moisture Content	2	Y *	Y #	-		
Particle Size and Shape Sieve analysis	1	Y *	Y *	-		
Test Requirement Checks	Item/Components	2. CONCRETING				
		a) Coarse Aggregate	b) Fine Aggregate/ Sand	c) Cement	d) Water	e) Concrete





TITLE:

QUALITY ASSURANCE TESTS AND INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024

VOLUME - IIB

SECTION - D

SUB SECTION- D24

REV. 0

DATE 03/10/2017

SHEET 5 of 6

CIVIL & STRUCTURAL WORKS

Remarks/Frequency of Test	1. Quantum of check for R.T. on butt welds under tension zone shall be 100% and for remaining butt welds unless specified shall be 10%. Acceptances norms for NDTs shall be as per AWS D1.1 2. RT on all butt welds for bunker supporting girders (Longitudinal/Transverse) shall be 100 %. 3. RT on all butt welds for deaerator supporting girders shall be 100 %. 4. All site fillet welds of bunker supporting structure shall be 100 % NDT. 5. All above quality control and super vision shall be carried out by an independent inspection body. * 100% on 'T' joints and 10% on longitudinal and circumferential butt welds.	
Hydraulic test		Y
All tests as per Indian/International Codes/Standards	Y	Y
Dimensional	Y	Y
Mechanical Test of Butt Weld Coupons	Y	-
Macrotech Exam. of Fillet Welds Coupons	Y	-
Fit up/Assy	Y	Y
Visual Exam.	Y	Y
Radiographic Test (RT) on Welds	Y	Y*
Liquid Penetration Test (LPT) on Welds	Y	Y
WPS/PQR/WQR	Y	Y
Ultrasonic Test (UT) on Material Above 40 mm Thickness	Y	-
Material T.Cs	Y	Y
Test Requirements	15. Structural Steel Like Columns, Girders, Beams & Truss Etc. 16. C.W. Pipes/Ducts	
Item/Components		

TITLE:

QUALITY ASSURANCE TESTS AND INSPECTION

SPECIFICATION NO. PE-TS-999-600-C024

VOLUME - IIB

SECTION - D

SUB SECTION- D24

REV. 0

DATE 03/10/2017

SHEET 6 of 6

CIVIL & STRUCTURAL WORKS

Warpage	16	-	-	-	-	-	Y	Y
Comp. Strength, bond strength working, time, chemical resistant	15	-	-	-	-	-	Y	Y
Compressive strength, Water absorption resistant to Acid, resistant to flexural strength, INEAD	14	-	-	-	-	-	Y	-
Positioning and location of laps and plumb level	13	-	-	-	-	Y	-	-
Storage	12	-	-	-	-	Y	-	-
Tests as per BHEL tech spec. and IS: 8183	11	-	-	-	Y	-	-	-
Check type of permanent colour coating	10	Y	Y	Y	-	-	-	-
Galvanizing test as per IS code	9	Y	-	Y	-	-	-	-
Check for coating of silicon modified polyester paint thickness	8	-	Y	Y	-	-	-	-
Dimensional conformity	7	-	Y	Y	Y	-	Y	-
T.Cs for fasteners &'Z' spacers	6	Y	-	-	-	-	-	-
Appearance	5	Y	-	-	-	Y	-	-
Sides end laps	4	Y	-	-	-	Y	-	-
Fixing of decking sheets	3	Y	-	-	-	-	-	-
Dimensional, thickness, depth of valley etc.	2	Y	-	-	-	-	-	-
T.Cs for Physical & Chemical properties	1	Y	Y	-	-	-	-	-
Test Requirements		17. Roof Decking sheets (Supply and fixing) 18. Wall Cladding work a) Outer sheet b) Inner sheet c) Insulation d) Fixing of wall cladding 19. Acid Resistant Lining a) Acid resistant Bricks/Tiles b) Acid resistant Mortar						
Item/Components								



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 1 of 41

VOLUME: II B

SECTION – D

SUB SECTION – D25

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002



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



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 2 of 41

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	GENERAL	3
3.0.0	EXECUTION	14
4.0.0	TESTING AND ACCEPTANCE CRITERIA	37
5.0.0	INFORMATION TO BE SUBMITTED	38

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 3 of 41	

TECHNICAL SPECIFICATION FOR REINFORCED CONCRETE CHIMNEY

1.0.0 SCOPE

This specification covers reinforced cement concrete works, including brick flue and insulation work, painting and protective treatment work, and other works associated with construction of RCC single flue chimney.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following:

- a) Furnish all labour, supervision, services, insurance, material, power, fuel forms, templates, supports, scaffolding, tools, plants, construction equipment, approaches, transportation etc. required for the entire work.
- b) Design and prepare working drawings for formworks, scaffoldings, supports, staging hoisting arrangement for men and material etc. and submit them for approval.
- c) Prepare and submit for approval, as per approved schedule, detailed drawings for RCC work in shell, platforms at various levels, roof and ground floor and bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.
- d) If in scope, prepare detailed fabrication and erection marking drawings for steel flues including flue expansion compensators, steel flue supports and restraint arrangements along with fittings and accessories and submit them for approval.
 - e) Prepare and submit for approval detailed shop drawings, with list of materials and material specifications for Load Bearing Insulation Blocks and Lateral Restraint Insulation Blocks.

	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 4 of 41	

- f) Prepare and submit for approval detailed schemes for operations like material handling, placement of concrete erection of steel flues, fixing of insulations, installation, dismantling and maintenance of flue expansion compensator etc. and for items like approaches, services etc.
- g) Design and submit for approval mix proportions for concrete to be adopted on job.
- h) Furnish samples and submit for approval the results of tests for various properties of the following materials:
 - i) Ingredients of concrete, (ii) Concrete,
 - iii) Acid/Chemical Resistant Tiles, (iv) Castable refractories, (v) Insulation materials, (vi) Paints. (vii) S/S liner.
- i) Provide all incidental items not specified or shown on drawings in particulars but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.
- j) Produce, if directed by the Engineer, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

2.2.0 Work by Others

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

2.3.0 Codes and Standards

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, along with those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the Engineer, shall be followed. "IS Specification" shall mean Codes, Criteria etc. of ISI.

- IS:6 Moderate heat duty fireclay refractories, Group-A.
- IS:104 Ready mixed paint, brushing, zinc chrome, priming.
- IS:158 Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting for general purposes.

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 5 of 41	
IS:195 Specification for fire clay mortar for laying fireclay refractory bricks. IS:269 Ordinary, and low heat Portland cement. IS:383 Coarse and fine aggregates from natural sources for concrete. IS:432 Mild steel and medium tensile steel bars. IS:456 Code of practice for plain and reinforced concrete. IS:516 Methods of test for strength of concrete. IS:732 Code of practice for electrical wiring installations (System Voltage not exceeding 650 Volts). IS:800 Code of practice for general construction in steel. IS:813 Scheme of symbols for welding. IS:814 Covered electrodes for metal arc welding of structural 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:818 Code of practice for safety and health requirements in electric and gas welding and cutting operations. IS:822 Code of procedure for inspection of welds. IS:875 Draft Standard for Code of practice for structural safety of buildings loading standards. IS:1080 Code of practice for design and construction of simple spread foundations. IS:1139 Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcements. IS:1161 Steel tubes for structural purposes. IS:1199 Methods of sampling and analysis of concrete. IS:1200 Methods of measurement of building works.			

 Maharatna Company	TITLE:	SPECIFICATION NO. PE-TS-999-620-C002	
	RCC STACK	VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 6 of 41	
IS:1230	Cast Iron Rainwater pipes and fittings.		
IS:1239 (Part-I)	Mild steel tubes.		
IS:1367	Technical supply conditions for threaded fasteners.		
IS:1526	Sizes and shapes for firebricks (230 mm. series).		
IS:1554	Cables.		
IS:1566	Hard-drawn steel wire fabric for concrete reinforcement.		
IS:1608	Methods for tensile testing of steel products.		
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.		
IS:1731	Dimensions for steel flats for structural and general engineering purposes.		
IS:1786	Cold-twisted steel bars for concrete reinforcement.		
IS:1791	Batch type concrete mixers.		
IS:1893	Criteria for Earthquake Resistant Design of Structures.		
IS:1947	Flood light.		
IS:1977	Structural steel (ordinary quality).		
IS:2062	Weldable structural steel.		
IS:2074	Ready mixed paint, red oxide - zinc chrome priming.		
IS:2309	Code of practice for the protection of buildings and allied structures against lightning.		
IS:2386 (Part-I)	Methods of test for aggregates for concrete. Particle size and shape.		
IS:2386 (Part-II)	Estimation of deleterious materials and organic impurities.		
IS:2386 (Part-III)	Specific gravity, density, voids, absorption and bulking.		
IS:2386 (Part-IV)	Mechanical properties.		
IS:2386	Soundness.		

 Maharatna Company	TITLE:	SPECIFICATION NO. PE-TS-999-620-C002	
	RCC STACK	VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 7 of 41	
(Part-V) IS:2386 (Part-VI) Measuring mortar making properties of fine aggregate. IS:2386 (Part-VII) Alkali aggregate reactivity. IS:2386 (Part-VIII) Petrographic examination. IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement. IS:2505 Concrete vibrators, immersion type. IS:2506 Screed board concrete vibrators. IS:2633 Methods of testing uniformity of coating on zinc coated articles. IS:2722 Portable swing weighbatchers for concrete (single and double bucket type). IS:2750 Steel scaffoldings. IS:2751 Code of practice for welding of mild steel bars used for reinforced concrete construction. IS:2950 Code of practice for design and construction of raft foundations. IS:3025 Methods of sampling and test (Physical and Chemical) for water used in industry. IS:3043 Code of Earthing. IS:3144 Methods of Test for Mineral Wool Thermal Insulation Material. IS:3346 Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot- plate method). IS:3495 (Part-I to IV) Method of test for clay building bricks. IS:3550 Methods of test for routine control for water used in industry. IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.			

 Maharatna Company	TITLE:	RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
			VOLUME - IIB	
			SECTION - D	SUB SECTION- D25
			REV. 0	DATE 09/12/2019
			SHEET 8 of 41	
IS:3677 Unbonded rock and slag wool for thermal insulation. IS:4014 Code of practice for steel tubular scaffolding. (Part-I&II) IS:4031 Method of physical tests for hydraulic cement. IS:4457 Ceramic Unglazed Vitreous acidresistant tiles. IS:4634 Method for testing performance of batch-type concrete mixers. IS:4687 Gland packing asbestos. IS:4832 Chemical Resistant mortars. IS:4860 Acid-resistant bricks. IS:4990 Plywood for concrete shuttering work. IS:4998 Criteria for design of reinforced concrete chimneys. (Part-I) IS:5410 Cement paint, colour as required. IS:5445 Long fluted machine reamers with Morse taper shanks. IS:5495 Sizes and shapes for firebrick (300 mm. and higher series). IS:6911 Stainless Steel plate, sheet and strip. IS:8112 High strength ordinary portland cement. IS:8183 Bonded Mineral Wool. IS:9595 Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels. CP326 - British Standard - Protection of structures against lightning. NEPA NO. 78 Code of protection against lightning. The Indian Electricity Rules. The requirements of Department of Civil Aviation, Govt. of India.				
2.4.0	Conformity with Drawings and Specifications			

	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 9 of 41	

The Contractor shall carry out all the work in strict accordance with the drawings stamped "Released for Construction" and specification issued to him and as per Contractor's detailed drawings approved by the Consulting Engineer. Prior to concreting, the Contractor shall prepare a check list on a set format of all items of work involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification, and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer. No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For Load Bearing Thermal Insulation block assembly and lateral restraint insulation block assembly, Contractor shall design sizes of all components of the blocks and details of their connections, supply and fabricate the same in accordance with the approved shop drawings prepared by him.

For steelwork and metal work, the Contractor shall design all connections, inserts for scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings prepared by him and/or as instructed by the Engineer, keeping in view the maximum utilization of the available sizes and shapes for metal components.

2.5.0 **Materials to be used**

2.5.1 **General Requirement**

All materials, whether to be incorporated in the work or to be used temporarily for the construction, shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.5.2 **Cement**

 BHEL Bharat Heavy Electricals Limited Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 10 of 41	

Ordinary Portland cement of grade 43, as per the requirements laid down in IS:8112, shall be used, until otherwise stated elsewhere in the specification.

2.5.3 Coarse Aggregate

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS:383 or IS:515 and shall be washed clean, if necessary. The maximum size of coarse aggregate for stack superstructure shall be 25 mm down graded, unless otherwise stated (vide serial 5(b) of clause 3.03.06). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.5.4 Fine Aggregate

Fine aggregate shall be river or pit sand, free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading falling within the limits of one of the three grades, mentioned in the relevant IS Specifications.

2.5.5 Water

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer.

2.5.6 Reinforcement

Mild steel or Medium or High Tensile steel deformed bars specified for reinforcement shall conform to the latest relevant IS Specifications and shall be of tested quality under ISI

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 11 of 41	

Certification Scheme. The reinforcement shall be free from any oil, foreign material or mill or rust scales.

2.5.7 Steel Flue

- a) All mild steel material to be used in construction of steel flue shall comply with IS:2062, IS:1239, IS:1367, IS:1608, IS:800 and with other relevant IS Specifications. The ultimate tensile strength of this steel shall not be less than 410 N/Sq.mm.
- b) Stainless steel liners shall be fabricated using materials conforming to the requirements of relevant IS Specifications and/or AISI 316L or BS:1449 Part-2. Grade of Stainless steel shall be equivalent to BS:1449 (Part-2) 316 S.12.
- c) Materials to be used for fabrication of Flue expansion compensator shall be suitable for the flue gas temperature and shall be acid resisting.

The Expansion compensator shall comprise several layers of materials given below in order from the gas side.

- i) Two layer of insulation, each consisting of heavy weight texturized glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 Kg/Sq.m
- ii) A continuous filament glass cloth coated both sides with a fluoro-elastomer having an approximate weight of 1.5 Kg/Sq.m.
- iii) Two layers of PTFE (Poly Tetra Fluoro-Ethylene) film of minimum thickness 0.15 mm each.
- iv) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 Kg/Sq.M.

2.5.8 Paints

Paints to be used for shop coat of fabricated steel shall conform to the IS:2074. Paint for treatment of outside face of Chimney with Cement water proof paint shall conform to IS:5410.

2.5.9 Acid Resistant Tiles and Castable Refractories



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 12 of 41

Acid resistant tiles to be provided over roof of stack should conform to IS:4457. Matching mortars to be used for tiles. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractory properties similar to Fire bricks conforming to IS:6, Group-A and working temperature shall be upto 1350 Deg.C.

2.5.10 Insulations**a) On Exterior Surface of Flues**

The normal flue gas temperature inside the flue shall be 145 Deg.C with momentary rise upto 400 Deg.C (Maximum) occasionally. The insulation material shall be able to withstand this temperature without any deterioration in thermal properties or breakdown. The thermal conductivity of the insulating material shall not exceed 0.06 W/M Deg.C at a mean temperature of 150 Deg.C. The insulation shall also not be affected by any acid condensation from flue gas and shall be free from any impurities which may cause corrosion to the flue material.

For steel flues 65 mm thick semi rigid resin bonded fibrous mineral wool of density not less than 96 Kg/Cu.m as per IS:8183 or resin bonded fibrous crown glass wool (high temperature) of same thickness and density not less than 36 Kg/Cu.m capable of sustaining temperature to the tune of 540 Deg.C without any loss of material thermal property, may be used. The mineral wool for exposed top portion of flue shall be semi-rigid with minimum density of 200 Kg/Cu.M or the glass wool for exposed top portion of flue shall have minimum density of 75 Kg/Cu.M.

Slag wool insulation shall not be accepted.

The insulation free from shots should be supplied in the form of mat to be fixed with staggered joints on outer surface of the flue with suitably spaced stud by galvanised wire mesh. Insulation on the top portion of flue shall be covered by stainless steel cladding.

b) At Load Bearing and Side Restraints of Flues

Load bearing insulation assembly to have (i) a properly mechned mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead/elastomeric sheet at top, and (iii) top plate formed of two numbers insulation blocks each made of minimum 50mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 and stainless

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 13 of 41	

steel plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and Mild steel to IS-2062. SINDANYO BLOCKS shall be suitable for operation at 320 Deg.C and shall primarily satisfy the following physical properties :

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

2.6.0 Storage of Materials

2.6.1 General

All materials shall be so stored as to prevent deterioration and intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material, which is deteriorated or is damaged or is otherwise considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed. The Contractor shall maintain an upto date accounts of receipt, issue and balance of all materials issued by the Owner.

2.6.2 Cement

Contractor shall store cement in water-tight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The doors of stores shall

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 14 of 41	

be at least 30 cm. above G.L. Deteriorated cement shall be removed immediately from the site. Not more than ten bags of cement shall be stacked one above the other.

2.6.3 Aggregate

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.6.4 Reinforcement

Reinforcement shall be stored preferably under cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.6.5 Steel, Metal and Fittings

All steel, metal and fittings to be used for fabrication and erection shall be stored sectionwise and lengthwise in separate stacks, off ground, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.6.6 Paints

Paints shall be stored under cover, in air-tight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in air-tight containers.

2.6.7 Steel Flue

Fabricated pieces of steel (flue) liner shall be stored systematically for ease of handling.

2.6.8 Insulation Material

All insulation materials like bearing insulation blocks, restraint insulation blocks, glass or mineral wool, asbestos ropes etc. shall be stored in packing boxes, under covered shed, avoiding their coming in contact with objectionable matter.

2.7.0 Quality Control

Contractor shall establish and maintain quality control for different items or work and materials as may be directed by the Engineer to assure compliance with contract requirement and submit to the Engineer records of the same.

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 15 of 41	

The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall not be limited to the following items of work :

- a) Cement : Test to satisfy relevant IS Specifications if supplied by the Contractor.
- b) Aggregate : Physical, Chemical and Mineralogical qualities, grading, moisture contents and impurities.
- c) Water : Impurities Test.
- d) Reinforcement: Material tests or certificates to satisfy relevant IS Specification if supplied by the Contractor.
- e) Structural : Material tests or certificate to satisfy Steelrelevant IS Specification if supplied by the Contractor.
- f) Steel flue : Material tests or certificate to satisfy relevant IS Specification if supplied by the Contractor.
- g) Stainless : Material tests or certificate to satisfy Steel relevant IS Specification if supplied by the Contractor.
- h) Acid Resistant : Compressive and tensile strength, acid tiles& mortar resistance and water absorption test.
- i) Mortar : Compressive and tensile strength, adhesion and acid resistance test.
- j) Insulation : Thermal conductivity, density, heat and acid resistance tests. Bearing capacity will be tested for bearing/restraint insulation blocks.

3.0.0 EXECUTION

3.1.0 Concrete

3.1.1 Trial Mix, Grades of Concrete

 BHEL Bharat Heavy Electricals Limited	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 16 of 41	

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables :

- i) Strength requirements of concrete : Table-2 of IS:456-2000.
- ii) Concrete Mix Proportion : Table-3 of IS:456-2000.
- iii) Minimum cement content/Cu.m. of finished concrete shall be as per Table 5 of IS 456-2000.
However, it should be noted that minimum cement content for concrete of chimney shell of grade M30,M35,M40 shall be 400kg, 430 kg and 450 kg respectively.
- iv) Limit of consistency : Refer Table in Item 3.1.4 of this specification.
- v) Cement/Total Aggregate Ratio : As per the following table.



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 17 of 41

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO (FOR GUIDANCE)

3.1 CEMENT/TOTAL AGGREGATES RATIOS

Workability	Water/ Cement Ratio	Ratio by Weight of Cement to Gravel Aggregate		Ratio by Weight of Cement to Crushed Stone Aggregate	
		20 mm. Size	38 mm. size	20 mm. size	38 mm. size
Very Low slump 0-25 mm.	0.4	01:04.8	01:05.3	01:04.5	1:05
	0.5	01:07.2	01:07.7	01:06.5	01:07.4
	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low slump 25-50 mm	0.4	01:03.9	01:04.5	01:03.5	1:04
	0.5	01:05.5	01:06.7	1:05	01:05.5
	0.6	01:06.8	01:07.4	01:06.3	1:07
	0.7	1:08	01:08.5	01:07.4	1:08
Medium slump 50-100mm.	0.4	01:03.5	01:03.8	01:03.1	01:03.6
	0.5	01:04.8	01:05.7	01:04.2	1:05
	0.6	1:06	01:07.3	01:05.2	01:06.2
High slump 100 - 175 mm.	0.4	01:03.2	01:03.5	01:02.9	01:03.3
	0.5	01:04.4	01:05.2	01:03.9	01:04.6
	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE-1 : Notwithstanding anything mentioned above, the cement / Total aggregate ratio is not to be increased beyond 1:9 without specific permission of the Engineer.

It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 18 of 41	

NOTE-2 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes. For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Engineer.

3.1.2 Batching of Concrete

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.1.3 Mixing of Concrete

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 19 of 41	

least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.1.4 Workability of Concrete

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 120 mm to 150 mm, where concrete is pumped, otherwise, 100mm-120mm slump in chimney shell works shall be adopted subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 3.3.6). The usual limits of consistency for various types of structure are given below:



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 20 of 41

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm. with Standard Concrete		Use for which Concrete is suitable
	Min.	Max.	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
1.1.1 High RCC structures		65	100 Very narrow and deep
1.1.2			with congestion due to reinforcement
1.1.3			and inserts.

NOTE: The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete.

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

3.1.5 Placing and Compaction of Concrete

Concreting shall proceed in a manner directed by the Engineer, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow

	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 21 of 41	

each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.1.6 Curing of Concrete

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor for curing.

	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 22 of 41	

3.1.7 Construction Joints

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.1.8 Ordinary Concrete

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS:456.

3.2.0 Reinforcement

3.2.1 Bending of Reinforcement

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS:2502.

3.2.2 Placing

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 23 of 41	

All reinforcement shall be placed and maintained in the position shown in the drawings.

Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer.

3.2.3 Fixing of Reinforcement

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

 BHEL Bharat Heavy Electricals Limited	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 24 of 41	

3.10 Forms

Construction by Slip-form Method

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

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

- i) Type and description of Slip-form equipment and its accessories.
- ii) Design of scaffolding and staging.
- iii) Description of materials including admixtures to be used for construction.
- iv) Manpower planning, construction spaces required, standby arrangement.
- vi) Rate of Slip-forming.
- vii) Proposed workability requirement of concrete and type of cement & admixture to be used.
- viii) Quality assurance programme.
- ix) Method of Transportation of material
- x) Method of curing and rectification of defects.

 BHEL Bharat Heavy Electricals Limited	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 25 of 41	

- xi) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.
- xii) Contingency solution for unplanned interruptions.
- xiii) Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Tenderer.

Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Tenderers, while quoting for Slip-form method of construction:

1. Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps are advisable:
 - a) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.
 - b) In areas where concrete thickness is 750 mm or more, rate of pouring should be such that minimum slipping of shuttering is maintained to avoid initial set of concrete before slip form movement.
 - c) Mix design should be so done that it will be self- lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.
 - d) Mix design also should be so done that it has a slump of around 100mm-120mm, at the point where concrete is placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent and plasticizer of approved manufacture may be added in mix to achieve this purpose.

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 26 of 41	
These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used. Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40 Deg.C. 2. Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect. 3. Every endeavour has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken: a) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm. b) Loading on Slip-form truss/yokes has to be fairly equal. c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around. 4. For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry. 5. In designing the mix following aspects should be borne in mind: a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm.per gram. b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.			

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 27 of 41	
c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 450 Kg. per Cu.M of concrete. d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/ Sq.mm. e) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes. 6. Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation. 7. It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights. In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilisation of the system. 8. Rate of slipping should be around 100 mm – 150mm per hour, subjected to a maximum limit of 3.0 m per 24hrs. 9. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc. It is desirable that jacking system, based on which the entire slip form system works, should consist of jacks 3 Tonne/ 6 Tonne capacity and a hydraulic pump with necessary pipe connections. Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.			

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 28 of 41	
Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks. 10. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck. 11. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke. 12. For effective utility of this technique following areas need careful attentions at the very conceptual stage: a) Detailed quality assurance programme. b) Advance Planning and preparations. c) Arrangement for on site supervision and adequate access facilities. 13. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work. 14. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement. Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system. 15. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc. 16. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and			

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 29 of 41	
reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete. For movement of personnel supervising the work a seperate hoist must be arranged for. 17. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform. 18. Winches for lifting men and material and mixers, if located within unnsafe area around chimney, should be protected by adequate shelter from possible damage. 19. Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below. 20. A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results. Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers. 21. In case of interruption in the course of slipping of formwork following measures should be taken: a) Provision of a key and additional reinforcement at the junction of new and old concrete. b) Slip form system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete. c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout. d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer. e) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel. 22. It is preferable to suspend the construction work under high wind condition. 23. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slip form technique with			

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 30 of 41	
enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators, having experience of similar construction in past. It is to be noted that enough manpower (as agreed by owners engineer at site) of above mentioned quality, is always ensured at site for smooth and uninterrupted work of slip form. 24. Operation of slip form method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity. 25. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer. 26. For smooth and unhindered supply of concrete, while the slip form is in operation, it is desired that batching plant for concrete of chimney shell be placed in close proximity of chimney shell. However, all the safety measures required for placing batching plant close to shell must be ensured. Safety measures as listed below must be adhered to but should not be limited to only these: a) Safety helmets and belts to be provided to all supervising staff and workers. b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer. c) Hand railing and toe guard to be provided around all openings and platforms. d) Regular maintenance of equipment, checking of hoists, scaffoldings etc. e) Passenger hoist must have multiple ropes with adequate factor of safety. f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.			

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 31 of 41	

g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

26. Permissible construction tolerances should be limited to the following:

Variation in wall thickness : (-) 5 mm, (+) 25 mm

Variation from Design Diameter : ($\pm$) 25 mm or ($\pm$) 2.5 mm per 3 m dia. whichever is larger, but in no case more than ($\pm$) 5 mm.

Out of Plumb in General : 1 in 1000 of height subject to a maximum of 200 mm.

3.4.0 Steel Flues

3.4.1 General

Fabrication and erection of Steel Flues shall conform to "Technical Specification for Fabrication and Erection of Structural Steelworks" furnished in this Specification.

3.4.2 Fabrication

Plates out of which flues will be fabricated, should be bent to the required shape on an appropriate machine. No smithy process shall be adopted for the purpose. Plates are to be prevented from distorting by more than the tolerances specified during transportation, storage, handling, erection and jointing. All components should be correctly located and brought into correct alignment and level within specified erection tolerances, before adjacent pieces are jointed or secured.

3.4.3 Assembly

Each flue would be assembled from its Component "Cans" near to ground level within the wind-shield. Incomplete flue would be hung only from the flue support platform during assembly, and progressively hoisted to enable connection of further cans at its lower end. Upon completion of the initial sectional length, this length will be hoisted and supported in its final position at the flue support floor as indicated in the drawing. It is envisaged that each flue will be assembled and hoisted in three sectional lengths; site joints between sectional length being located just above a steel floor level.

Joints between individual cans should be flanged and bolted on outside and to have sealed welded joints on inside in accordance with clause 3.3.0 - "Welded Construction" under Technical Specifications" for Fabrication of

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 32 of 41	

structural steel work. The Contractor shall submit a drawing showing proposals for erection and indicating locations of all site joints which should be kept to minimum.

3.4.4 Flue Expansion Compensator

For installation of Expansion Compensators, the manufacturer's instruction should form the basis of the Contractor's method. This method, in a statement, should be submitted to the Engineer for approval. Once approved it has to be followed throughout the installation sequence. Expansion Compensators should be prevented from distortion during transportation, handling, erection and jointing, by more stringent tolerances than specified by the manufacturer.

3.4.5 Tolerances

Permissible tolerances in the fabrication and erection of steel flues are given below :

- a) Internal diameter shall not vary by more than : $\pm 12 \text{ mm}$
- b) Centre of any section shall not be eccentric from vertical centre line by more than : 10 mm in any 15 metre height
- c) Centre of any section at height 'h' is in mm. above GL shall : $(h/2500 + 10) \text{ mm}$, not be vertical centre where line by more than
- d) Local deviation from a true circular form should not exceed the shell thickness (Measurement should be made from a segmental circular template having radius of flue shown in drawing and a chord length equal to 0.15 of that radius).
- e) Peaking or stepping at welded horizontal seams shall not exceed 4 mm. (Measurement shall be made with a straight edged template long enough to contact the straight shell on either side of the peaked area).

3.4.6 Erection

Erection of Steel Flues and C.I. Chimney caps shall be done as per requirement of IS:800.

The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 33 of 41	

provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

3.5.0 Insulation and Protective Treatment

3.5.1 Acid and Heat Resistant Paint

Top 15 meters of the outside face of R.C.C. windshield horizontal surface at the top of windshield and inside face from the top of the windshield to the top of roof slab or as specified in the drawing shall receive a protective treatment of three coats of acid and heat resistant black paint. The quality and type of the paint shall have the prior approval of the Engineer. For this, a small area shall be painted and a sample of paint shall be shown to the Engineer.

The surface to be painted shall be prepared and primary coat, if required as per the paint manufacturer's specification and direction of the Engineer, shall be applied. The paint shall conform, unless otherwise stated, to the requirement of IS:158. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for his approval. The surface to be painted shall be completely dry before the paint is applied and the drying time between consecutive coats shall not be less than 5 hours. The overall combined thickness of paint shall be a minimum of 230 microns.

3.5.2 Cement Paint

The outside face of the Chimney shell, unless specified otherwise, shall be painted with Cement water proof paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS:5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

3.5.3 Insulation and Packing

All insulation material should be of dimension and type, shown in the drawing. Load bearing insulations at supports and side restraints of Steel liners should be an assembly of M.S. Plates, Stainless Steel Plates, PTFE (Poly Tetra Fluoro Ethylene) sheets and or/asbestos fibre reinforced boards (SINDANYO BLOCKS). Insulation to be fixed on outer surface of steel flues should be made of glass or mineral wool.

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 34 of 41	

a) Load Bearing Insulation Block

Load bearing assembly should consist of three units and be fabricated according to approved drawings. It would be fabricated from mild steel units with a stainless steel sheet bearing plate and load bearing insulation blocks as indicated in drawing.

The first unit is bolted to the supporting beam. It consists of a M.S. base plate with bolt holes on which a machined M.S. plate is welded. This plate is provided with recess for PTFE sheet (conforming to BS : 5400) to seat, being lubricated with silicon grease.

The second unit also consists of a M.S. plate having adequate size & thickness as shown in drawing. While one surface of the plate is provided with a stainless steel bearing plate the other surface has a thin layer of lead/ elastomeric sheet. The side having stainless steel surface is placed on PTFE surface of First unit.

The third unit consists of two layers of load bearing insulation blocks each having a minimum thickness of 50 mm and factory bonded to top & bottom M.S. plates. These are separated by 100 mm. long load bearing insulation dowels as shown in the drawing. These plates are in turn welded to two additional M.S. plates. Of the two surfaces thus created one shall be welded to bracket assembly while the other should rest on the lead sheet of second unit. Bearing assembly, thus formed, should be levelled by using suitable M.S. shims.

Support arrangement typically consists of flue support shoe (a part of flue), flue support bracket connected to the shoe by precision bolted connection. The bracket in turn is welded to the bearing assembly, which in turn is bolted to available supporting beams.

Support brackets and bearing assembly are welded to locally thickened area of flue. These support the flue on support platform at suitable locations indicated on the drawing.

The arrangement described above should cater for easy and smooth thermal movements of linear element. Suitable restraint brackets and M.S. stop plates need be provided as shown in drawings to prevent excessive movement and thus keeping different units of bearing assembly in proper position.

b) Insulation Block at Lateral Restraints

At flue restraint platforms, necessary restraint arrangement with load bearing insulation blocks and stainless steel bearing plates fixed to the insulation blocks should be provided as indicated in drawings.

 BHEL Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 35 of 41	

Restraint and support brackets need be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

c) **Glass or Mineral Wool**

Insulation thickness of 65 mm as is specified in clause 2.05.10 shall be built up using two (2) layers composed of 40mm and 25 mm thick insulation blocks. Thicker layer shall be put as first layer around the flue on its exterior surface.

The insulation on the flue shall be fixed using chicken G.I. wire mesh, G.I. wire ties, insulation retaining studs, washers etc. All joints shall be staggered. The insulation shall be tightly secured to the exterior surface of the flue by impaling on the studs and fixing in place by means of 63mm round or square metal plated speed washers. 20 gauge galvanized wire netting shall be wrapped continuously over the entire exterior of insulation. The wire mesh shall be 25mm hexagonal pattern conforming to IS:1566. All joints in the mesh shall be tapped a minimum of 150 mm tied by 16 gauge soft annealed wire at 300 mm spacings. Lacing at joints shall not be used. The Contractor before application of insulation, shall take prior approval of actual fixing arrangement from the Engineer.

The insulation shall be able to sustain structural vibrations and shall not settle under such conditions during erection, construction & operation. The insulation shall be suitably tied to prevent dislocation under adverse conditions.

The cladding of stainless steel sheet over the insulation shall be well secured using pins, fasteners etc.

d) **Vermiculite Concrete**

Vermiculite concrete shall be made by mixing exfoliated vermiculite, portland cement and water. It shall be of Grade-B, having a density of 210 Kg./Cu.M. The vermiculite aggregate size shall be maximum 6 mm. The mix shall be 1 cement and 8 vermiculite by volume.

3.6.0

Acid-Proof/Chemical Resistant Protection to Roof Slab

Acid-Proof/Chemical Resistant tiles bedded on acid proof/chemical resistant mortar shall be provided for the protection of roof slab. The intervening space between the tiles shall also be filled up by chemical resistant/acid-proof epoxy mortar grouts. The mortar shall be used immediately after mixing.

Tiles shall be made of clay, feldspar or quartz and vitrified at a high temperature in ceramic kilns. These should be unglazed, free from

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002		
		VOLUME - IIB		
		SECTION - D		SUB SECTION- D25
		REV. 0	DATE	09/12/2019
		SHEET 36 of 41		
deleterious materials and should conform to IS:4457. Iron oxide in the raw materials used, shall not exceed 2 percent. They should show a fine grained, dense and homogenous fracture when broken. They shall be sound, true to shape, flat and free from flaws and other manufacturing defects. Dimensions of the tiles shall be 198.5 x 198.5 x 35 mm. Depth of the groove on the underside shall not be more than 3 mm. Compressive and tensile strengths of the tiles shall not be less than 70 N/Sq.mm and 3.5 N/Sq.mm respectively.				
3.7.0	Flue Acid Drains and Manholes			
Flue acid drainage system, where provided, will comprise of collection sumps, dilution manholes, conveying pipes including connection to main drainage system.				
Stainless steel pipes, bends, collection sumps, fixing straps, bolts etc. conforming to the relevant Indian Standards (or in absence of which British Standard BS:3605) shall be used in work. Pipes should be cut and joined as per manufacturer's instructions so as to leave the surface clean and square to the axis of pipe.				
Manhole should be constructed as per drawing. However, for general guidance it may be noted that pit of required dimensions should be excavated, lean concrete (1:2:4 mix) of required thickness to be laid, Acid-proof/Chemical resistant brick masonry in 1:4 acid resistant cement mortar of necessary thickness be built and both sides plastered by 12mm thick acid proof plaster (1:3 mix) having waterproof admixtures.				
Manholes should be covered by reinforced concrete slab on which a heavy duty (HD) manhole cover with frame having diameter 560mm and total weight 255 Kg (140 Kg for manhole and 115 Kg for cover) is to be fixed. For additional safety another inner cover or other approved methods may be adopted. The manhole cover shall be distinctively coded to indicate the type of drainage involved.				
Inside manholes necessary channels and benchings finished smooth by neat cement in cement concrete (1:2:4) and foot rungs made from 20mm round bars at 300mm centres and staggered should be provided. Rungs should project 100mm from wall face and be embedded 200mm inside cement concrete block made in that location of brick work. These foot rests shall be painted with coal tar in the projected portions and cement slurry in the embedded part. Joint of any pipe with brick work shall be rendered perfectly leak proof.				
Pipes and fittings in the connection pipe to the main drainage system shall be vitrified clayware conforming to relevant IS and laid to the line and level indicated in the drawings.				
3.8.0	Roof Drainage			
3.8.1	General			



TITLE:

RCC STACK

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D25

REV. 0

DATE 09/12/2019

SHEET 37 of 41

Rainwater outlets and down comers to run along inner face of stack wall, shall be made of standard cast iron rainwater pipes conforming to IS:1230. The brackets used to hold the pipes alongside the walls shall be wrought iron clevis type, split ring type or of perforated strap iron as approved by the Engineer. Each vertical pipe shall hang freely on its bracket fixed just below the socket. Suitable spacer blocks are to be kept in between the pipe and wall surface for fixing the pipe. All bends and junctions shall be provided with water tight clean-outs.

3.8.2

Pipe Joints

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water tight when under ground. Method of pipe cutting and jointing shall be as per instruction of the pipe and fittings manufacturer or as approved by the Engineer. However following guidelines may be followed in absence of any instruction available from the manufacturer.

Socket and Spigot pipes shall be joined by cast lead joints. Spigot of the following pipe should be centred in the socket of the preceding pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. After the gasket or hemp yarn has been caulked tightly, a jointing ring shall be placed round the barrel and tightened against the face of the socket to prevent air lock. Molten lead shall then be placed round the barrel and tightened against the face of the socket. Thereafter molten lead should be poured in to fill the remainder of the socket and caulked with suitable tools tight round the joint to make up for shrinkage of the molten metal on cooling and should be finished 3mm behind the socket face. If any joint is suspected to be damaged it has to be opened out & redone. Joints in cast iron pipes with special jointing arrangements like "Tyton" joints etc. shall follow the instructions of the manufacturer.

4.0.0

TESTING AND ACCEPTANCE CRITERIA

4.1.0

General

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specifications and as supplemented herein, for the following items or any other item as may be required by the Engineer unless otherwise specified in this specification. The Contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to him, the original test results in triplicate, within seven days after the completion of the test. Engineer may present himself while such tests are being carried out.

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 38 of 41	
4.2.0	Cement	Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the Purchaser/Manufacturer/Supplier for carrying out the tests for fineness (by hand sieving), setting time, compressive strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard. If the cement is supplied by the Contractor the test shall be carried out by him. The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer, in accordance with IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant IS specifications.	
4.3.0	Water	Sampling and testing of water being used for concrete works shall be carried out as per IS:3550, by the Contractor, at regular intervals and whenever directed by the Engineer. The final acceptance criterion in case of doubt shall be as per IS:3025.	
4.4.0	Concrete	The Contractor shall take cubes for works test as per requirement laid down in IS:516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS:456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement of IS:456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild, provided a satisfactory method of load testing is not possible. Such testing or demolishing and rebuilding shall be carried out by the Contractor.	
4.5.0	Steel Flue	All site and shop welded joints shall be inspected and tested in accordance with clause 4.00.00 of Technical specification for Fab. and Erection of structural steel work.	
4.6.0	Insulations	The insulating materials shall be tested for its stipulated characteristics and properties in accordance with the latest editions of IS:3144 and IS:3346 and/or as directed by the Engineer.	

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 39 of 41	

5.0.0

INFORMATION TO BE SUBMITTED

5.1.0

With Tender

The following technical information are required with the tender:

a)

Source and arrangement of processing of aggregates proposed to be adopted.

b)

Type of plant and equipment proposed to be used.

c)

Names of firms with which association is sought for to execute the special items of work e.g. flue expansion compensator, load bearing insulation blocks etc. in the contract.

d)

Types of formwork proposed to be used. All details as per clause no. 3.03.06 to be submitted, if slip form method is proposed to be used.

e)

Shop proposed for fabrication of steel (flue) liners. Detailed write-up on procedure of erection of complete liner system including details of equipment proposed for the same.

f)

For insulating material tests to be offered for inspection & tests for which test certificates will be submitted. A drawing showing the details of fixing insulation on the flues at bearings, lateral restraints and exterior surface.

g)

Proposal for lifting of men and material in constructing the chimney.

5.2.0

After Award

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.2.1

Programme of Execution and requirement of Materials

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirement of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms & conditions of the Contract. In case the Contractor proposes to take on hire any

 Maharatna Company	TITLE: RCC STACK	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D25
		REV. 0	DATE 09/12/2019
		SHEET 40 of 41	
machinery or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted. The master programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work. Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.			
5.2.2	Samples	Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.	
5.2.3	Design Mix	Design mix as per details of this specification giving proportions of ingredients, sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work. Further, the mix design for concrete of shell to be validated from a third party agency of national repute, as agreed upon by the owner.	
5.2.4	Detail Drawings	Following items shall be provided by the Contractor which are to be approved by the Owner and Consultant. a) Detail drawings and designs of form work including scaffolding to be used. If slipform method of construction is adopted, then detail drawings showing all the arrangements for slipform technique including methods for reducing internal diameter and providing required slopes on outer diameter. b) Detail drawings and bar bending schedules for concrete components. c) Shop drawings for structural steel and metal work, including inserts etc. The Contractor shall submit his proposal for testing site and shop joints provided in steel members.	

 BHEL Bharat Heavy Electricals Limited	TITLE:	RCC STACK		SPECIFICATION NO. PE-TS-999-620-C002	
				VOLUME - IIB	
				SECTION - D	SUB SECTION- D25
				REV. 0	DATE 09/12/2019
				SHEET 41 of 41	

- d) Detail drawings for templates and temporary supports for embedments.
- e) Category wise requirements of MS, tor and structural steel including GI flats of various sizes for procurement.
- f) Detailed drawings of steel flues indicating details of joints, supports and restraints including insulation blocks, and details of expansion compensator.
- g) Detailed drawing of hoisting arrangement for men and material satisfying statutory regulations laid down for safety purpose.

5.2.5

Reports

Following Test Reports shall be furnished by the Contractor:

- a) Mill Test Report for cement and reinforcing steel if the materials are supplied by the Contractor.
- b) Inspection Report of bought out items.
- c) Inspection Report of formwork and reinforcement, insulations etc.
- d) Reports of tests of various material and concrete.
- e) Radiographic tests on welded joints in steel flues.
- d) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship.



TITLE:

**BOROSILICATE GLASS BLOCK
LINING SYSTEM**

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE 19/02/2020

SHEET 1 of 8

VOLUME: II B
SECTION – D
SUB SECTION – D26
BOROSILICATE GLASS BLOCK LINING SYSTEM

SPECIFICATION NO. PE-TS-999-620-C002



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



TITLE:

**BOROSILICATE GLASS BLOCK
LINING SYSTEM**

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE

19/02/2020

SHEET 2 of 8

Table of Contents

1. Project Description
 - 1.1 Description
 - 1.2 Flue gas characteristics
 - 1.3 General configuration
2. Scope of work
 - 2.1 scope of supply
 - 2.2 Bidder services
3. Special equipment, Tools and Instruments
4. Standard and codes
5. Quality assurance and quality control
6. Safety, Noise and Environment requirements
 - 6.1 Safety
 - 6.2 Environment data
7. Mechanical Technical Requirement
 - 7.1 Design parameters
 - 7.2 Operating conditions
 - 7.3 Performance Requirements
 - 7.4 Design requirements
 - 7.5 Material requirements
8. Handling, Storage and protection
 - 8.1 Facilities
 - 8.2 Storage
9. Job site inspection and preparation

 BHEL Maharatna Company	TITLE: BOROSILICATE GLASS BLOCK LINING SYSTEM	SPECIFICATION NO. PE-TS-999-620-C002	
		VOLUME - IIB	
		SECTION - D	SUB SECTION- D26
		REV. 0	DATE 19/02/2020
		SHEET 3 of 8	

1 PROJECT DESCRIPTION

1.1. Description

This specification covers borosilicate glass block lining system in thermal power plant chimney.

1.2. Flue gas parameters

The chimney shall be working with the flue gas parameters as per Annexure-I.

1.3. General configuration

The Chimney general arrangement configuration shall be as provided elsewhere in the specification. However, during detailed engineering, modification may be done.

2 SCOPE OF WORK

2.1 Work to be provided by the contractor, unless specified otherwise, shall include but shall not limited to following:

2.1.1 Design, preparation of working drawings, material supply, erection, application, Handling, transportation, storage, preservation, pack and furnish with adequate moisture proof packing and test of borosilicate glass block lining system on flue liner substrate including:

- a) Suitable primer, two component suitable adhesive membrane and closed cell borosilicate glass blocks.
- b) Required Surface finish of flue liner substrate as recommended by borosilicate glass block lining system manufacturer/supplier.
- c) Installing borosilicate glass block lining system on flue liner substrate using two component suitable adhesive membrane under controlled temperature and humidity conditions, including skilled labor, material, tools & tackles, equipment required to create controlled temperature & humidity conditions during installation, hot blow cleaning (after priming, if required) of flue liner substrate before application, mixing of two component suitable adhesive membrane by automated mixing machines etc. all complete.
- d) Complete onsite QA and supervision, by borosilicate glass block lining manufacturer/supplier, during surface finish of flue liner substrate, application of primer, application of two components suitable adhesive membrane, installation of borosilicate glass blocks on flue liner substrate

2.1.2 All necessary parts, and works necessary for transport, storage and application purposes.

2.1.3 Submission of the drawings and getting the same approved from BHEL and the project owner.



TITLE:

**BOROSILICATE GLASS BLOCK
LINING SYSTEM**

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE 19/02/2020

SHEET 4 of 8

- 2.1.4 The contractor shall furnish all design, labor, materials, tools and equipment necessary for the installation of borosilicate lining system, as indicated and specified herein.
- 2.1.5 The Work shall include everything requisite and necessary to finish the job properly, to the satisfaction of engineer in charge, notwithstanding that every item of labor or materials or accessories required to make the installation complete may not be specifically mentioned.
- 2.1.6 The Equipment / material for the Unit shall be supplied complete with provisions for appurtenances and accessories, to form a complete system which will achieve and assure safe and reliable operation with best overall performance.
- 2.1.7 Contractor shall provide, in the required format and form and in a timely manner, all drawings and documentation required by this Specification and/or required by applicable Standards and codes. A consistent nomenclature shall be used project-wide in naming all component parts within the Scope of Work. This shall apply to all drawings, Bill of Materials, special instructions, etc. The cost of correcting inconsistent nomenclature shall be borne by the contractor.
- 2.1.8 Changes in design and drawings already approved by the owner are normally unacceptable. However, should such changes become necessary on an exceptional basis, the contractor shall obtain the owners approval prior to introducing any such change.

2.2 Contractor Services

Field personnel provided by the contractor shall be capable and qualified to perform the required duties to the satisfaction of BHEL and the owner.

3 SPECIAL EQUIPMENT, TOOLS AND INSTRUMENTS

Contractor shall provide all special equipment, tools and instruments, skilled manpower required for handling and storage, and for test and maintenance of borosilicate glass block lining system provided under this Contract.

4 STANDARDS AND CODES

4.1 The borosilicate glass block lining system to be provided under this Specification, including all appurtenances and accessories, shall be designed, inspected, tested, stamped and preserved to the extent indicated in said referenced standards and codes. Where this Specification does not include such reference, the system, or any of its components, shall be designed, inspected, tested and preserved, as applicable, to comply with currently recognized International and/or manufacturer's/suppliers specification, whichever is stringent and more restrictive.

4.2 In all cases contractor shall adhere to and comply with the requirements of Indian standards, which are found to be more restrictive than those specified herein.

5 QUALITY ASSURANCE AND QUALITY CONTROL

5.1 The contractor shall submit upon request a copy of Its Quality Assurance Manual including Quality Procedures.

	TITLE:	SPECIFICATION NO. PE-TS-999-620-C002	
	BOROSILICATE GLASS BLOCK LINING SYSTEM	VOLUME - IIB	
		SECTION - D	SUB SECTION- D26
		REV. 0	DATE 19/02/2020
		SHEET 5 of 8	
5.2 The contractor shall conduct an inspection and testing program which shall record and verify the essential properties of the constituent materials and the finished liner. 5.3 The contractor shall conduct test to verify the mechanical properties of borosilicate glass blocks and two components suitable adhesive membrane and the tests shall be documented during the course of design and shall be made available to owner. 5.4 Unless otherwise specified the contractor, standard tests shall be performed on all batches of materials furnished. The owner may or may not elect to witness tests, but the contractor shall notify the owner in advance of all scheduled tests. 6 SAFETY, NOISE AND ENVIRONMENT REQUIREMENTS 6.1 SAFETY The material and equipment supplied under this specification shall meet the U.S. "OCCUPATION, SAFETY, AND HAZARD ADMINISTRATION" (OSHA) requirements or equivalent. 6.1.1 Jobsite Safety and Scrap Disposal ○ Safety programs and procedures shall be within the scope of this specification. It should be noted that materials that are potentially flammable, must be handled in keeping with good industry practice and in compliance with the manufacturer/supplier recommendations. ○ Proper disposal of scrap and waste materials shall be followed by the contractor as instructed by owner. 6.1.2 Safety and protection of material, work and property: The contractor shall provide for the safety and protection of the work, materials and equipment to be incorporated therein, whether in storage on or off the site. Provide protection at all times against rain, wind, storms, condensation, or heat so as to maintain all work, equipment and materials free from damage. At the end of each day, all new work likely to be damaged shall be appropriately protected. 6.2 Environmental Data 6.2.1 The contractor, upon request shall provide a plan for the treatment of the discharge/waste to meet current regulations of the Indian government/ regulatory authorities. 6.2.2 The contractor, upon request shall provide additional information on noise and/or other environmental data. All information shall be prepared in a manner acceptable to Indian government/ regulatory authorities. 7 TECHNICAL REQUIREMENTS			



TITLE:

**BOROSILICATE GLASS BLOCK
LINING SYSTEM**

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE 19/02/2020

SHEET 6 of 8

7.1 Design parameters

7.1.1 Liner considerations

The borosilicate glass blocks shall be of suitable thickness as per the scope. Proper provisioning should be made for borosilicate glass block lining system for protection around gas sampling ports, expansion joints, man holes, mini-shell and other appurtenances.

7.2 Performance Requirements

7.2.1 Borosilicate glass block lining system shall be designed in such a way that it will not require unscheduled outages for repair except for planned and scheduled routine maintenance and inspections.

7.2.2 Borosilicate glass block lining system and all of the required components shall be designed for a safe, useful life of thirty (30) years (minimum).

7.2.3 Ten (10) year full replacement guarantee, including supply, erection, enabling works, labor, material (borosilicate glass blocks, two components suitable adhesive membrane, suitable primer), surface preparation, arrangement for application etc. all complete, and fulltime onsite QA supervision during erection & commissioning.

During the guarantee period if the lining system fails to protect the subject surface from deterioration, the contractor shall replace the partially affected portion or complete borosilicate glass block lining system without any additional cost.

7.2.4 The borosilicate glass block lining system shall be offered by a manufacture/supplier with demonstrated capabilities in the area of onsite technical support and QA/QC supervision, who employs QA/QC supervisors with a demonstrated experience in technical support and QA/QC supervision of the subject lining system.

7.2.5 The borosilicate glass block supplied lining system shall be capable of withstanding fire risk for a minimum period of 2 hours as per ASTM E-119 or equivalent codes/standards. Proper certification from an independent institute of sufficient knowledge and experience shall be submitted by supplier subject to acceptance by the project owner, showing the capability of the borosilicate glass block lining to protect the steel chimney flues from structural damage by fire of said rating.

7.2.6 Contractor shall produce certificates from an independent institute of sufficient knowledge and experience, subject to acceptance by the



TITLE:

BOROSILICATE GLASS BLOCK LINING SYSTEM

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE 19/02/2020

SHEET 7 of 8

project owner, showing that the workers can do the work on supplied lining system safely, without any adverse health effects and without requiring excessive protective measures.

7.3 Design Requirements

7.3.1 General

- Design of the borosilicate lining system must be performed by a professional engineer in the design of such system for thermal power plant chimneys.
- Requirements of this specification are to be regarded as minimum requirements. If the manufacturer/supplier design and/or experience dictate these minimum requirements should be exceeded, the design, supply and application shall be performed accordingly, without any extra cost implication.

7.4 Materials Requirements

The flue liner substrate shall be internally protected with borosilicate glass block lining system consisting closed cell borosilicate glass blocks, two components suitable adhesive membrane and suitable epoxy primer meeting all of the following requirements:

7.4.1 The borosilicate glass block lining system shall use closed cell borosilicate glass blocks with the following properties:

- a. Density of $0.19 \times 10^3 \text{ kg/m}^3$ (+/- 20%).
- b. Coefficient of linear thermal expansion not greater than $5.7 \times 10^{-6}/^\circ\text{C}$.
- c. Min. compressive strength of 1.00Mpa as per ASTM C165/C240.
- d. Minimum flexural strength of 0.62 Mpa as per ASTM C203/C240.
- e. The blocks shall be resistant to thermal cyclic loading under FGD bypass/ hot gas service conditions, and sudden temperature changes, including high temperature spikes.

7.4.2 The borosilicate glass block system shall use a flexible, chemically resistant adhesive, with all required surface preparation, primer, labor, equipment etc., all complete. The adhesive membrane shall be a 2-component having excellent elastomeric properties and be acid & heat resistant. The adhesive membrane shall be applied in between and behind the blocks in a minimum 3 mm thick layer ensuring a proper bond and adhesion. The adhesive membrane shall have the following properties.

- a. Minimum tensile strength at 23 °C of 1.0 N/mm² as per ASTM D412
- b. Resistant to corrosive flue gas environments.
- c. Remain elastomeric and flexible under hot gas conditions and sudden temperature changes.
- d. The adhesive shall be suitable for trowel application.



TITLE:

**BOROSILICATE GLASS BLOCK
LINING SYSTEM**

SPECIFICATION NO. PE-TS-999-620-C002

VOLUME - IIB

SECTION - D

SUB SECTION- D26

REV. 0

DATE 19/02/2020

SHEET 8 of 8

- 7.4.3 The steel substrate shall be grit blasted to a cleanliness of SA 2 1/2 and approved by the manufacturer/supplier of the borosilicate glass block lining system. The substrate shall thereafter be primed using a high performance epoxy primer within a short time window approved by the manufacturer/supplier. The lining system manufacturer/supplier shall demonstrate a proven Quality Control system that monitors and documents the key physical properties, as described above.

8 HANDLING, STORAGE AND PROTECTION

8.1 Facilities

- 8.1.1 Contractor shall construct adequate facilities for the storage of material. Upon completion of fabrication, the contractor shall remove the fabrication facility from the site and return the area to the pre-construction condition.
- 8.1.2 The installation of borosilicate lining system must be done in a suitable environment (temperature, humidity etc. control as per manufacturer recommendation to stand by the required guarantee). Maintenance of the required suitable condition and any tools/tackles, machinery required to maintain the controlled environment during installation of borosilicate glass block shall be in the scope of contractor.

8.2 Storage

- 8.2.1 Materials shall be stored in a dry area and within the temperature and humidity limits recommended by the manufacturer/supplier. Do not allow shelf-life limits, as determined by the manufacturer/supplier, to be exceeded.
- 8.2.2 Materials surfaces shall be protected from dust, fog, rain and other contaminants.
- 8.2.3 Affected materials shall be removed if any of the above requirements are not met.

9 JOB SITE INSPECTION AND PREPARATION

- 9.1 In coordination with the chimney contractor the borosilicate glass block lining system installation agency should submit a plan detailing the application sequence and methods to be employed, including moving, handling, storage, erection, fit up and the methods to be used for environmental protection.

ANNEXURE-I

OPERATING CONDITIONS (Per FGD Absorber)						
DESCRIPTION / LOAD		Guarantee Point	Design Point			
		TMCR	BMCR			
Flue Gas Flow	t / h	2894.995	3052.550			
Flue Gas Volume	m ³ / s	721.2244	766.3178			
Flue Gas Temperature	°C	48.8	49.8			
Flue Gas Density	kg / m ³	1.115	1.1065			
FGD OUTLET-FLUE GAS COMPOSITION % BY VOLUME – (WET BASIS)						
CO ₂		14.62	14.33			
N ₂		71.08	69.78			
O ₂		2.94	3.34			
SO ₂		0.0055	0.0052			
H ₂ O		11.35	12.54			



SPECIFIC TECHNICAL REQUIREMENT

STACK ELEVATORS

SPECIFICATION NO. PE-TS-N53-503-A-001

VOLUME II B

SECTION C

SUB-SECTION A6

REV. 0

SHEET 1 of 5

SECTION - C SUB SECTION – A6 STACK ELEVATORS

	SPECIFIC TECHNICAL REQUIREMENT STACK ELEVATORS	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION C	SUB-SECTION A6
		REV. 0	
		SHEET 2 of 5	

1.

SYSTEM DESCRIPTION

1.1

The Rack and pinion type stack elevator is required for installation inside multi-flue or outside single flue chimney. The stack Elevator is normally used for the movement of the maintenance personnel and for materials such as refractory bricks, etc. for maintenance of chimney.

2.

SCOPE OF SUPPLY AND SERVICES

2.1

The scope of supply and services covered under the specification are broadly described below:

2.1.1

One No. Rack and Pinion type stack elevator complete with all other accessories and associated steel work.

2.1.2

Drive motor and control panel for Stack elevator.

2.1.3

Control Panel.

2.1.4

Equipment earthing

2.1.5

All power and control cables, trailing cables.

2.1.6

Limit switches.

2.1.7

Over speed governor.

2.1.8

Alarm push button in the cage connected to battery operated alarm at elevator base.

2.1.9

Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase of power supply.

2.1.10

Continuous duty electrical torque motor recoil cable reels or cable trolley or any equivalent arrangement to maintain electrical power service to all electrical components of the elevator for complete travel of stack elevator.

2.1.11

One auxiliary panel shall be provided and mounted on the graded level enclosure equipped with a main ON-OFF selector switch, main contractor, breaker, relays, control transformer and fuses, tone frequency transmitter or equivalent arrangement, terminal blocks and all other accessories required for normal operation of the elevator.

2.1.12

One main control panel shall be furnished and mounted on top of the cab. Panel shall be in enclosure equipped with necessary equipment like rectifier, battery charger, tone frequency receiver, contactors, breakers, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.

2.1.13

Cab shall be controlled by semi-automatic floor selection control system. Cab shall be furnished with 240 V grounding receptacle, emergency alarm push button with normally open contact, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the main control panel to aux. Panel at ground level. Cable shall supply the cab necessary power supply requirements. Cable guides shall be installed at every 6 m intervals to avoid entanglement of this cable. Control signal between the aux. Panel at ground level, the main control panel on the cab and the landings shall be provided with tone frequency receiver or any other equivalent arrangement by trailing control cable.

	SPECIFIC TECHNICAL REQUIREMENT STACK ELEVATORS	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION C	SUB-SECTION A6
		REV. 0	
		SHEET 3 of 5	
2.1.14	Each landing assembly shall include a limit switch and push button control station installed and wired to a landing junction box.		
2.1.15	All power cable and race way shall be provided and installed by the bidder for interconnection of the main control panel, auxiliary panel and landing junction boxes. Trailing cables shall be as per relevant IS/IEC standard.		
2.1.16	Bidder shall provide, install and connect a system equipment ground to owner’s chimney grounding system. Equipment grounding system shall electrically connect panels and junction boxes which contain electrical devices, motors and elevator platform and structures. Raceway system shall not be considered as an equipment ground.		
2.1.17	All enclosures containing electrical devices shall be provided with 240 V, single phase heaters with adjustable thermostat control.		
2.1.18	Cab shall be equipped with a 240 V AC interior light and duplex outlet.		
2.1.19	Cable accessories as required to install the cables in bidder’s scope shall be provided by the bidders.		
2.1.20	Complete erection, testing and commissioning including all erection materials, consumables and other tools and tackles required for erection along with commissioning spares.		
2.1.21	All inserts, anchor bolts, sleeves, anchoring steel and any other items required to complete the job satisfactorily shall be in bidder’s scope.		
2.1.22	First fill of lubricant and consumables shall be in bidder’s scope.		
2.1.23	Satisfactory running and maintenance of elevator for a continuous period of 30 days including training of owner’s operators.		
2.1.24	Supply of One complete set of special maintenance tools and tackles shall be in bidder’s scope.		
2.1.25	Any other equipment or accessories not specified, but required for the satisfactory operation of chimney elevator shall be in bidder’s scope.		
2.1.26	Recommended spares including instrumentation for 3 years of normal operation of stack elevator. (List to be furnished by the bidder and for which order shall be placed separately by owner as per their requirements)		

	SPECIFIC TECHNICAL REQUIREMENT STACK ELEVATORS	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION C	SUB-SECTION A6
		REV. 0	
		SHEET 4 of 5	

3.	SPECIFIC REQUIREMENTS
3.1	The equipment supplied, erected and commissioned shall meet the technical requirements of respective Section –D and Data Sheet-A.
3.2	Bidder shall note that all QP and Field quality plans shall be subject to purchaser’s approval.
3.3	All equipment offered shall have suitable provision of termination and connection of power and control cables inclusive of cable boxes, lugs and glands, etc.
3.4	All the equipment shall be suitable for the power supply fault level and other climatic conditions as indicated in project information.
3.5	The bidder shall guarantee the rating and performance parameters of the system/equipment offered in accordance with specification requirements.
3.6	It is the responsibility of bidder to arrange license for operation of chimney elevator from statutory body of that area before handing over.
3.7	Bidder shall furnish deviation (clause wise) in the deviation schedule. In absence of dully filled deviation list, it will be presumed that offer is exactly in line with the technical specification.
3.8	Bidder shall furnish duly filled data sheet –B along with the offer. In absence of same, offer shall be treated as incomplete.
3.9	Bidder shall offer the stack elevator considering prevailing statutory and regulatory requirements of project location.
3.10	Bidder shall indicate degree of protection of various electrical equipment in the offer.
3.11	Makes of all bought out items shall subject to purchaser’s approval after award of contract.
3.12	All drawings/documents shall subject to purchaser’s approval after award of contract.
3.13	Please refer / comply customer- specification (<i>rack & pinion type elevator</i>).

**SPECIFIC TECHNICAL REQUIREMENT****STACK ELEVATORS**

SPECIFICATION NO. PE-TS-N53-503-A-001

VOLUME II B

SECTION C

SUB-SECTION A6

REV. 0

SHEET 5 of 5

DATA SHEET

1)	Designation Elevator	:	Rack and Pinion Type Stack
2)	Type of loading	:	Passenger cum goods
3)	Quantity project requirement.	:	1 nos. for 150 M high Chimney.
4)	Carrying Capacity	:	400 Kg (approximately)
5)	Pay load	:	400 Kg min.
6)	Operating Speed	:	40 m/min.
7)	Dimension of lift and lift well/cut out	:	As per IS: 3534
8)	No. of landings	:	<u>For 150 M High Chimney=</u> Five (05) nos. including ground (0.0m, 45m, 75.6m, 106.2m and last landing at 136.8m)
9)	Total vertical travel	:	136.8m
10)	Electrical power supply system	:	415 V, 3 ph, 50 Hz.
11)	Other accessories	:	As required



VOLUME: II-B

SECTION-II

STACK ELEVATOR

1.00.00 INTENT OF SPECIFICATION

This Specification covers design, constructional features, material requirement, manufacture, erection, performance requirement, testing etc. of One (1) no. Rack & Pinion type Vertical Stack elevator complete with all driving equipment, auxiliaries and accessories for 150 meter long twin flue wet chimney (Stack) with borosilicate lining.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture, inspection and testing of Elevator shall comply with all currently applicable statutes, regulations and safety codes. Other internationally acceptable standard/codes, which ensure equal or higher performance than those specified shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Owner/ consultant shall be final and binding. The design unless specifically stated otherwise, confirm to following specific codes and standards as applicable, including its latest amendments subsequent to the date of publication as mentioned below:

2.01.01	IS: 14665 (Part-1) :	Electric Traction Lifts, Guidelines for outline dimensioning.
2.01.02	IS: 14665 (Part-2) :	Electric Traction Lifts, Code of practice for installation, operation & maintenance.
2.01.03	IS: 14665 (Part-3) :	Electric Traction Lifts, Safety rules.
2.01.04	IS: 14665 (Part-4) :	Electric Traction Lifts, Components.
2.01.05	IS: 14665 (Part-5) :	Electric Traction Lifts, Inspection Manual.
2.01.06	IS: 7759	: Specification for Elevator door locking devices and contacts
2.01.07	IS-2365	: Specification for Steel Wire Suspension Ropes for Lifts and hoists.
2.01.08	State's Elevator and Escalator Act.	
2.01.09	State's Elevator and Escalator Rules	
2.01.10	Indian Electricity act.	
2.01.11	Indian Electricity Rules.	

2.02.00 Wherever specified or required the Plant shall conform to various statutory regulations. Wherever required, approval for the equipment supplied under the specification from statutory authorities shall be the responsibility of the bidder.



3.00.00 SCOPE OF WORK

3.01.00 One (1) no. Rack & Pinion type Vertical Stack elevator complete with all driving equipment, auxiliaries and accessories for 150 meter long twin flue chimney /Stack shall be supplied by the bidder.

The scope of work shall include design, engineering, fabrication, installation, commissioning and testing of rack and pinion type elevator including required enclosures, elevator, mast and guide rail, cab drive unit machinery, power cables, control cable, mechanical and electrical equipment for bi flue chimney. The elevator including electrical and mechanical components shall be installed inside the chimney. The design of the elevator shall be in such a way that the elevator operation shall be safe even with expected maximum deflection of the chimney structures. Contractor shall submit the elevator GA and cross section drawing along with the bid for review.

The stack elevator and accessories to be furnished and put into operation and all other required services are detailed herein under. The items, though not specifically mentioned herein but needed to make the system complete in all respects and reliable for safe and smooth operation and guaranteed performance shall also be treated as though included and the same shall be furnished, unless otherwise specifically excluded elsewhere. The items, though not specifically mentioned below but mentioned elsewhere in the specification shall be included in the scope of work.

The required equipment and services shall be as described below:

- i) One (1) no. 400 kg (minimum) capacity rack & pinion type stack elevator complete with all other accessories and associated steel works.
- ii) Electrical equipment such as motors, starters, switches, switch gears, control panels, interlocks, control & power cabling and earthing of electrical equipment.

3.02.00 Accessories

Each elevator shall consist of following:

- a. Elevator car complete with door, door hangers and tracks, push button station, operating panel, car position indicators, illumination fittings, fan fittings and other required accessories. Lighting point and plug point shall be provided over the elevator car roof for the purpose of maintenance work.
- b. Mast, guide rails, Cab, Cab Frame, Cab doors, guide rollers and structural steels, terminal buffers and guide rail lubrication device.
- c. Complete drive machinery and accessories e.g. electric motor, gear box etc., electrical and control equipment including cables & isolating switch including Power & lighting distribution boards etc.
- d. Necessary brakes and limit switches, safety locks for car and landing door & all other protective devices including switch, fuse, starters etc.





All rigid/flexible conduit, ferrules, lugs, glands, terminal blocks, cable clamps, general purpose flexible/Trailing cables automatic leveling device and other miscellaneous items as required.

- e. Hoist-way doors and push button station with digital lights at each landing.
- f. Provision of Battery back-up for emergency lighting inside the Elevator car and alarm, in case of power failure.
- g. Facility of intercom in the Elevator car with necessary wiring for connection from car to a terminal box adjacent to bottom most landing and to the Plant Control room as well as Maintenance Engineer room.
- h. Any other fittings and accessories required for safe and efficient operation of the equipment.
- i. Firemen's switch as per rules of fire lifts.

4.00.00 DESIGN & CONSTRUCTION

4.01.00 General

4.01.01 This section covers the design, engineering, fabrication, installation, commissioning and testing of the rack and pinion type vertical lift elevator including required enclosures, elevator, mast and guide rail, cab drive unit machinery, buffers, power cable, control cable, mechanical and electrical equipment. The design of the elevator shall be in such a way that the elevator operation shall be safe at all times.

4.01.02 Elevator shall be capable of operating from the ground floor to the top landing with intermediate stops at all landings as stipulated.

4.01.03 All mechanical and electrical operating devices and trailing cable shall be designed for outdoor operation with dusty and high humidity conditions and shall operate equally well in any ambient temperature as per project synopsis. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100 degrees C when the elevator is not operating.

4.02.00 Enclosures

A three-sided ground enclosure with one access door shall be provided for ground landing. At each platform landing above ground level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high and epoxy primer coated with two coat of the manufacturer's standard primer and finish paint.

The ground landing shall be provided at a suitable height above the foundation slab to ensure safety and space underneath the cage for buffer and stop. Foundation should be at least 100 mm above local grade. The





space underneath the landing shall be surrounded by foundation enclosure. A staircase shall be provided for access to the cage. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the cabin is at a landing. Doors shall be bi-parting and swinging type.

Base of the three-sided enclosure shall be securely anchored to the ground level floor slab using expansion type anchors.

4.03.00 Mast

Mast shall be provided in sections of approximately 1.52 m length welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the structure at suitable distances.

4.04.00 Cab

4.04.01 Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.

4.04.02 Cab floor shall be skid resistance glass fiber reinforced plywood or approved equal. Cab shall be attached to a framed structure and form an integral part with the drive mechanism located at the top of the cab.

4.04.03 Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.

4.04.04 Cab roof shall be provided with an escape hatch electrically interlocked with elevator control system. Tubular steel handrail shall be provided on the cab roof for maintenance purposes.

4.04.05 Cab door and landing level enclosure doors shall be electrically and mechanically interlocked to prevent the cab from being operated unless the cab door and landing level enclosure doors are fully closed and to prevent the doors from being opened while the cab is in motion. Cab door shall be of Closed Collapsible Sliding Gate type with manual operation.

4.04.06 One no. cabin fan, two no. recessed fluorescent lamp fittings and one no receptacle with duplex outlet (5A,240V each) to be provided alongwith one no. emergency light with battery charger. Cab interiors shall be paneled with stainless steel sheets.

4.05.00 Drive Unit & Safety Device

4.05.01 Drive unit located on top of the cab shall be complete with AC squirrel cage induction motor, reduction gear, drive pinion and an over speed governor.

Drive unit shall incorporate an Electro Hydraulic Thruster (EHT) type brake and an external manual brake release. The mechanical compression spring shall be held off by hydraulic pressure. This hydraulic pressure shall be





provided by EHT brakes. In the event of power failure, the brake shall be automatically applied & will stop the cab. The brake shall be of self adjusting type and released by means of a special handle provided in the cab.

- 4.05.02 An overspeed governor in constant mesh with the rack by means of a pinion shall be incorporated to protect the cab against overspeed during the cab downward motion.

At a predetermined speed higher than normal, the centrifugal action of the governor pawl shall actuate the incorporated brake mechanism and stop the downward motion of the cab smoothly. The brake shall remain locked on following this action and has to be manually reset before normal elevator operation can be resumed.

- 4.05.03 A remote control shall be provided testing the safety device of the with remote control facility.

- 4.05.04 The drive system shall be designed so that it will be capable to operate smoothly without any tendency to rock or judder with all vertical, horizontal forces as well as the moments through the rack.

- 4.05.05 A safety device shall be provided in conjunction with the drive unit & shall have a separate flame hardened steel pinion engaging in the rack. The device shall be actuated by centrifugal weight & stops the elevator smoothly in case the normal traveling speed exceeds. The safety device shall remain locked on following this action & has to be manually reset before normal elevator operation can be resumed. For testing the safety device, the elevator shall be provided with a remote control facility. Bidder shall ensure that no person is in cab during the test.

- 4.05.06 The elevator shall be provided with a centrifugal brake to prevent accidental tripping of the safety device if, in case of power failure, the cage has to be taken to the ground by gravity. The motor brake shall be released mechanically by a lever in the cage to allow the cage to move down. The centrifugal brake shall keep the preset speed lower than the tripping speed.

- 4.06.00 Buffers

Sufficient number buffers of spring loaded /hydraulic type shall be fitted below the cab. The buffers shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment.

The number of buffers shall be fixed as to ensure proper sharing of impact loads by all of them.

- 4.07.00 Power and Control

All electrical components furnished with the elevator shall be completely wired, energized and checked. Necessary power distribution arrangement shall be provided by the Contractor to feed electrical power to elevator.

All electrical control devices shall be in enclosures. Equipment furnished shall



include the following:

- a) Momentary contact push button for raise/lower control.
- b) Reversing combination motor starter with a moulded case circuit breaker for the motor. Starter shall be equipped with three thermal overload relays for motor protection. Operating handle for the combination starter circuit breaker shall be accessible from inside the cab and shall also serve as an emergency stop switch.
- c) Deleted.
- d) Over travel protection, emergency stop push button, over speed governors.
- e) All electrical and mechanical interlocks on cab access door and landing level enclosure doors, phase reversal protection shall be provided.
- f) An alarm push button shall be provided in the cage connected to a battery operated alarm at the elevator base. Simultaneous alarm shall also sound at the unit control room (UCR) in the event of any fault in the stack elevator for which one potential free contact shall be provided in each elevator for audio visual alarm in PCR for "Stack Elevator Fault" indication.
- g) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.
- h) Continuous duty electric torque motor recoil cable reels as required to maintain electrical power service to all elevator electrical components throughout the limits of travel.
- i) One auxiliary panel shall be furnished and mounted on the grade level enclosure. Panel shall be equipped with a main "ON-OFF" isolating switch, main contactor, relays, control transformer and fuses, tone frequency transmitter, terminal blocks and all other accessories required for normal operation of the elevator.
- j) One main control panel shall be furnished and mounted on the top of the cab. Panel shall be equipped with necessary equipment like rectifier, battery, charger, tone frequency receiver, contactors, MCBs, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.
- k) Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling. Degree of protection of the control cabinets shall be IP-52 as per IS:2147. Control cabinets shall be provided with hinged door(s) with padlocking arrangement. All doors, removable covers and plates shall

be gasketed all around with neoprene gaskets, louvers, when provided, shall have screens and filters. The screens shall be of fine wire mesh made of brass. Suitable cable gland plate shall be supplied fitted on to this gland plate. All cable glands shall be screwed on type and made of brass.

- l) Each motor to be controlled from the control cabinet shall be provided with 3 pole isolating switch. HRC fuses, contactors of AC4 duty class with thermal overload relays with single phasing preventer and other equipment required for satisfactory control motor. The isolating switch and contactor shall be rated atleast 20% more than the connected motor full load current. Motors of 0.37 KW and above shall be rated for 415 V, 3 Phase and below 0.37 KW will be 240 V single phase supply.

The controllers and resistors for motors shall conform to IS-8544 (latest edition) and IS-2959 (latest edition) and shall be continuously rated for 150% full load current of the motor. Switches shall be hand operated, air breaker heavy duty, quick make, quick break type conforming to IS-4064. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal/abnormal conditions such as full load, overload, locked rotor, short circuit etc. The incoming power supply isolating switch shall be inter-locked with the control cabinet door so as to prevent opening of the door when the switch is closed. Device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

- m) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 KA. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive without danger of contact with live metal.
- n) Contractor shall provide dry type transformers with class B insulation for control power supply, lighting and space heating. Control supply will be 240 V AC. Transformer for control supply shall be provided with a control tap at 110 V which will be earthed. Power and control supply to individual drives and users shall be distributed with separate isolating switches and primary and secondary fuses.
- o) All push buttons shall be of push to actuate type having 2 "NO" and 2 "NC" self-reset contacts. They shall be provided with integral escutcheon plate engraved with their functions. Push button contacts shall be rated for 5 Amp at 415 V AC and 1 Amp. inductive breaking at 250 V DC. Mushroom type emergency push button to open the main contactor shall be provided in the operator's cabin and two on the bridge platform within easy reach. Indicating lamps shall be of the filament type and low watt consumption lamps shall be provided with series resistors.



- p) Strip type space heaters of adequate capacity shall be provided inside in each cabinet.
- q) Control cabinets shall be supplied completely wired. All wiring shall be carried out with 650 V grade PVC insulated, stranded conductors. Power circuits shall be wired with stranded aluminium conductors of adequate sizes to suit the rated circuit current, the minimum size shall be 6 sq.mm Control circuits shall be wired with stranded copper conductors of sizes not small than 2.5 sq.mm. Control circuits shall be isolated from power circuits.
- r) Cab shall be controlled by a semi-automatic floor selection control system. Cab shall be furnished with 240 Volt grounding type receptacle, emergency alarm push button with a normally open contact rated 0.5 Amp. at 220 V DC, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Cable guides shall be installed at every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level and the main control panel on the cab, will be provided with the tone frequency receiver. However control and interlocks from the landings shall be connected to the auxiliary panels located at ground level through fixed cables. The power and control cables and trailing power cables shall be FRLS type.
- s) Each landing assembly shall include a limit switch for door interlock and push-button control station installed and wired to a landing junction box.
- t) Cable trolley with cable guides for recoil of cable on to cable reel to maintain electrical power service to all elevator component through out the limits of travel.
- u) Contractor shall furnish, install, and connect a system equipment ground to the Owner's existing chimney ground system. System equipment ground shall electrically connect panels and junction boxes which contain electrical devices, motors, and elevator platforms and support structure. Raceway system shall not be considered as an equipment ground.
- v) All enclosures containing electrical devices shall be provided with 240 Volt, single-phase space heaters with adjustable thermostat control.
- w) All power cables and raceway shall be furnished and installed by the Contractor for interconnection of the main control panel, auxiliary panel and landing junction boxes etc. Conductors included in the cable shall be as required to energise all electrical equipment furnished with the elevator. Transmission of alarm signals is done by means of tone frequency equipment. Hence communication conductors are not required.



4.08.00 Electric Motor

Elevator drive motor shall be squirrel-cage induction type designed and fabricated to conform to the requirements indicated on the drawings.

Motor shall be designed for operation at the required speed; 415 Volts, 3 phase, 50 hertz, and shall be suitable for full voltage starting, S4 duty class as per IS-4722 with CDF of 25% and maximum number of 120 starts per hour in 55 Deg. C ambient temperature. Motor shall be tested at the factory to determine that it is free from electrical or mechanical defects.

Motor nameplate KW rating shall not be exceeded when the equipment is operating within the limits of the maximum load requirements.

Motor shall have sealed Class B non-hygroscopic insulation (IS-325) or equivalent international standard including two additional dips and bakes of epoxy varnish or vacuum impregnation. Insulation system shall be the motor manufacturer's standard premium insulation offering.

Motor shall be totally enclosed and furnished with cast iron frame, brackets, gasketed conduit box and fan cover. Motor shall be furnished with grease pre-lubricated, double-shielded, anti-friction bearings having life rating of not less than 42,500 hours under coupled service retirements. All exposed metal surfaces shall be protected with a polyester paint or coating which is moisture and corrosion resistant.

Motor shall be provided with internal 240 Volt AC single-phase space heaters or an alternate heating system to prevent condensation within the motor during extended periods of idleness. Motor heating system shall be acceptable to Owner.

Motor and driven equipment shall be direct coupled or belted as required, and mounted on a common base plate with coupling or belt guard. Motor shall be completely assembled, lubricated, and ready for operation.

Intent of these specifications is that the motor supplied be designed and constructed for the intended service. Motor construction and duty cycle shall conform with all requirements of applicable safety codes and standards for the service. For additional requirements Volume-II B section-III shall be referred to.

4.09.00 Raceway

a) General

Complete raceway system for the elevator shall be furnished and installed in accordance with this section and the Contractor's shop drawings as reviewed and accepted by the Owner. The Contractor shall provide drawings for acceptance showing the routing of conduit

and wiring for the control circuits associated with the elevator.

Raceway system is defined to include conduit and all related materials and devices required to support, secure and provide a complete system for support and protection of electrical cable and wiring.

Raceway shall be furnished and installed as required to extend raceway which has been installed under separate specifications for entry for circuits to the chimney facilities from external plant area. Raceway shall be provided for all cable and wiring installed under these specifications.

b) Materials

Raceway shall be rigid galvanised steel conduit, provided in accordance with IS-1653 (latest edition).

Steel conduit, couplings and elbows shall be hot-dip galvanised rigid mild steel. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. Thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage. Flexible conduits shall be plastic jacketed, liquid tight galvanised steel.

Galvanised steel fittings shall be used with galvanised steel conduit. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction.

Bushings shall be provided at the termination of all conduit not terminated in hubs and couplings. Insulated bushings with insulating inserts in metal housings shall be provided on conduit 32 mm diameter and larger. Insulated bushings shall be grounding type standard bushings and shall be galvanised.

One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

Raceway supports shall be galvanised steel materials. Hanger rods shall be 13 mm diameter threaded steel rods. Supports for conduits in single runs or groups of two shall be one- hole cast metal straps and clamp-backs unless other types are acceptable to the Owner. Supports for banks of three or more conduits shall be constructed of support channels with associated conduit clips. Support channels for galvanised steel conduit shall be hot-dip galvanised after fabrication.

Junction box enclosure, type, and material shall be as indicated on the drawings or as stated in these specifications. Junction boxes, pull



boxes, and cabinets shall not have knockouts. Junction boxes for indoor service shall be of sheet steel hot-dip galvanised after fabrication and shall be dust resisting enclosure. Except as indicated otherwise in these specifications, all junction boxes for use in outdoor or damp locations shall be galvanised malleable iron or equivalent cast ferrous metal. Junction boxes and outlet boxes installed on the exterior shall be galvanised steel.

Outlet boxes, switch boxes, and associated fittings shall be galvanised iron or equivalent cast ferrous metal.

c) Installation

Contractor shall field route conduit according to the general routing indicated on the drawings reviewed and accepted by the Owner and shall coordinate conduit locations with other equipment and structures. Wherever practical, conduit shall be routed so that, except where it is changing elevation or being lowered to enter equipment, the lowest part of the conduit, including its associated supports and appurtenances, is at least 2.1metres above the closest walking surface beneath it. Conduit, including its associated supports and appurtenances, routed above work areas, walkways and platforms, shall be at least 2.1metres above the closest walking surface beneath it. It may be routed a reasonable distance away from the supporting wall of ceiling, so long as the specified support is provided, interference with other equipment and structures is avoided, and the routing is acceptable to the Owner. Conduit including its associated supports and appurtenances, which must be routed closer than 2.1metres above the closest walking surface beneath it shall be routed as close as possible to surface of walls and the equipment served. Except as otherwise specified or indicated on the drawings, all conduit shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Vertical conduit runs between platforms, shall be routed on the inside wall of the concrete chimney. Conduit which is stubbed up shall remain plugged until the conduit is extended. Conduit field routing shall be acceptable to the Owner. Routing if not acceptable, shall be rerouted and replaced without any expense to the Owner.

Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

Metal conduit shall be joined by threaded conduit couplings with the conduit ends butted. Use of running threads will not be permitted. Where metal conduit cannot be joined by standard threaded couplings, conduit unions or split couplings may be used if both material and location are acceptable to the Owner. Only ground seat type water-tight unions shall be used where the union may be submerged.

Run of conduit shall not contain more than the equivalent of four quarter bends, including those immediately at outlets or fittings. Bends in conduit



shall be made without reducing the internal diameter of the conduit. Use of a pipe tee or vise for bending conduit will not be permitted. Inside radius of conduit bends shall be not less than six times the inside diameter of the conduit. Conduits deformed or crushed in any way shall be removed from the job site.

Plane of all conduit ends shall be square with the center line. Where threads are required, they shall be cut and cleaned prior to conduit reaming. Ends of all conduits shall be reamed to remove all rough edges and burrs. Cutting oil shall be used in threading operations, the dies shall be kept sharp, and provisions shall be made for chip clearance. All steel conduit, after threading, shall be regalvanised by an acceptable galvanising process. Contractor shall supply this protective material and shall apply it in the field.

Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. Locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box.

Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulations cannot be removed by methods acceptable to the Owner, the conduit shall be replaced.

Equipment and devices which move in relation to the supply conduit due to vibration, normal operation of the mechanism, or thermal expansion shall be connected to the supply conduit using not more than 760 mm of flexible conduit adjacent to the equipment or device.

Expansion fittings shall be installed between rigidly mounted fittings in vertical raceway. Distance between expansion fittings in any individual raceway shall not exceed 15 metres.

All conduit runs shall be rigidly supported. Each conduit shall be supported within 300 mm of Junction boxes and fittings. Support spacing along conduit runs shall be as follows:

Conduit Size	Maximum Distance Between Supports
Smaller than 40 mm dia. :	1.5 metres
40 mm dia. and larger :	3 metres

Cabinets and boxes shall be rigidly mounted. Mounting on concrete shall be with bolts and expansion anchors. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both. Cabinets shall be levelled and fastened to the mounting surface with not less than 7 mm air space between the enclosure and mounting surface. All mounting holes in the enclosure shall be used. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be



centered on structures. Conduit openings in steel boxes shall be made with a hole saw or shall be punched. Cable support boxes shall be installed to be accessible from platforms.

Where supports for raceway, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with expansion shell anchors with externally split expansion shells, single cone expander and anchor break off grooved checking cones.

Contractor shall be responsible for all openings for passage of electrical raceways. Required openings not provided during chimney construction shall be provided by the Contractor using a hacksaw, a hole saw or a core drill subject to the acceptance by the Engineer-in-Charge. Opening in concrete for single conduits shall be cut by the Contractor with core drills and the conduits shall be grouted in place after being installed.

Field cutting of grating will be allowed only where specifically acceptable to the Engineer-in-Charge. Alternate routing of raceways should be used to avoid conflict with grating. If field cutting is absolutely necessary, the openings shall be made at divisions or ends of grating sections. Openings shall be square and shall be neatly finished. Rough spots shall be ground until smooth and re-galvanised as required. Openings in grating shall be sawed, not burned.

Openings that have been cut through concrete for the passage of raceways shall be finished by grouting around the conduits.

Welding shall completely fuse the welded member to the supporting steel and shall be neat in appearance. Clamps shall be used for making attachments to structural steel for installation purposes wherever possible. Welded lugs will be permitted only when specifically accepted by the Engineer-in-Charge. All temporary supports which have been welded to the structural steel shall be removed as promptly as possible. After removal, the roughened surface of the steel shall be ground smooth and a protective primer paint applied equal to that which was initially applied in the shop.

Unfinished runs of raceways shall not be used. Supports and connections for each raceway run shall be completed prior to the pull-in of any pulling line or conductor.

4.10.00 PVC Insulated FRLS Cable

a) Materials

Vol-II-B section-III of this specification shall be referred for FRLS cable. Unless specified otherwise, Contractor shall submit to the Engineer-in-Charge four copies of the manufacturer's test report on each cable furnished. Conductor accessories including terminal materials like glands, lugs etc. markers, tying materials and cable support shall be furnished and installed. Wire termination materials for conductors 10 sq.mm and larger shall be pressure or bolted type. Terminals for conductors smaller than 10 sq.mm shall be an insulated pressure connection in the shape of a ring.





b) Installation

Power and control cables shall be routed as required by the drawings. Cables pulled into the wrong conduit or cut too short shall be replaced. Cables removed from one conduit shall not be installed in another conduit.

Only lubricants recommended by the cable manufacturer and acceptable to the Owner shall be used.

Outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. Thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

Pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to indicate the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected. Extreme care shall be exercised during the installation of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. Permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations.

Cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jacket or insulation. Adequate cable end lengths shall be provided and properly installed in junction boxes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings.

Final inspection shall be made after all cables are in place and where supports and bushings deform the cable jacket, additional supports shall be provided as directed by the Owner. Additional cable protection such as a wrapping of light rubber belting, friction tape or similar material may be required. Cables in vertical runs shall be supported as indicated on the drawings.

Not less than 8 mm shall be allowed in each 15 metres vertically supported length of conductor for expansion and contraction.

Contractor shall identify the ends of all power and control circuits. He shall also identify all circuits in pull boxes. Each marker shall bear the number of the corresponding circuit according to the drawings.



Splices shall not be made in conductors.

Terminations shall be in accordance with the following requirements :

- i) Train cable in place and cut squarely to required length. Avoid sharp bends.
- ii) Remove necessary amount of cable jacket and insulation without damage to the conductor.
- iii) Install terminals or connectors as required, ensuring a firm metal-to-metal contact.
- iv) If the connection requires insulation, (i.e. cable connects to insulated conductors), apply three half- lapped layers of insulating tape over the joint, extending to two cable diameters over the cable jacket and a similar distance over any other insulation or connection requiring insulation.

Insulated conductors shall be tested after installation with a 1000 volt megger or an equivalent testing device and shall indicate approximately infinite resistance between conductors of the same circuit and between conductors and ground. Equipment and labour required for testing shall be provided by the Contractor. Any circuit failing to test satisfactorily shall be replaced or repaired and retested as directed by the Owner.

4.11.00 Earthing

a) General

Earthing system furnished and installed shall include a complete earthing system for the elevator. Earthing equipment and materials shall be furnished and installed in accordance with the reference codes and standards, these specifications, and the Contractor's shop drawings as reviewed and accepted by the Owner.

b) Materials

The earthing of all electrical items shall be supplied by the Bidder. For earthing of various equipment, conductor sizes shall be as listed below:

i)	MCCs Motors above 90 KW control panels, cable trays, etc.	:	50 x 6 sq.mm G.I.flat
ii)	Motors above 30 KW, upto 90 KW and lighting panel/ control panels/auxiliary panels	:	35 x 6 sq.mm G.I.flat
iii)	Motors above 5 KW upto 30 KW	:	25 x 3 mm G.I. flat



- iv) Motors upto 5 KW and misc.
small item like conduits,
junction boxes etc. : 8 SWG G.I. Wire

The earthing strip/wire shall be connected to the earthing mat by the Bidder provided in the chimney area. Clamps and other hardware of iron or steel used with the grounding system shall be hot-dip galvanised. Bolts, washers and nuts shall be hot-dip galvanised steel.

c) Installation

Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surface or equipment, the conductors shall run parallel or normal to dominant surfaces.

Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed one (1) metre. Damaged earth system conductors or cables shall be repaired or replaced by the Contractor as directed by the Owner.

Earth connections except equipment earthing connections shall be made by electric arc welding. Bolted connections shall be used for earthing equipment.

Earthing bushings within all enclosures, including equipment enclosure, shall be wired together and connected internally to the enclosure earthing lug at earthing bus with bare conductor.

Electrical equipment shall be earthed. Large equipment will be furnished with earthing bus. Most other equipment will be furnished with earthing pads and/or earthing lugs. Earth connection surfaces shall be cleaned immediately prior to connection. Where the earth conductor is included with the power conductors in the motor circuit raceway a compression type earth conductor termination shall be used and connected to the motor frame inside the motor terminal housing. Where the earth conductor is not included with the power conductors in the motor circuit raceway, the motor frame shall be earthed to the earth grid.

Suitable earthing facilities acceptable to the Owner shall be furnished on motors not so equipped. Earthing facilities shall consist of compression type earth conductor termination bolted to the motor frame and providing a minimum of joint resistance. Conduit system is not considered to be earthing conductor. No earthing conductor shall be smaller in size than 4 sq.mm unless it is a part of an acceptable cable assembly.

5.00.00 OPERATION AND CONTROL PHILOSOPHY

- 5.01.00 The elevators, while starting from any level, shall start at rated speed but during stopping, elevator shall slow down to lower speed when the car reaches around one meter of the selected landing floor and stop when reached the landing floor. The control system shall be through





microprocessor based AC variable voltage and variable frequency drive with remote control and wireless technology.

5.02.00 The stack elevator shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms. Bottom cage shall be rested on ground and the Bidder shall provide ladder to take entry to the elevator from ground level.

5.03.00 The stack elevator shall be attendant operated and shall not be under automatic mode of operation.

5.04.00 The operation of the elevators shall be through soft touch keys located inside the lift car. Suitable interlock shall be provided so that the elevators shall not

move unless the door is properly closed. The landing doors of any floor shall not open when the elevator is not on that floor. Soft touch keys shall be fixed in one car for holding the doors open for any length of time required.

5.05.00 The elevators under this section shall be treated as "Fire Lifts". "Fire Switch" in a glass front box shall be provided adjacent to the lifts at the entrance level, the function of which is to enable the fire authority to take over the complete control of the lifts, when required. When the switch is on, landing call points shall become inoperative and the lift shall be on the car control only. When the switch is off, the lift will return to normal working.

6.00.00 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND SITE

6.01.00 The details of the checks to be carried out in the various equipments are to be submitted by the contractor for owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the quality assurance plan to be agreed with the owner.

6.01.00 All forgings shall be subjected to ultrasonic test to ensure free from internal defects in addition to check for chemical and mechanical properties.

6.02.00 10% of the welds selected at random shall be subject to DP test.

6.03.00 All forged components shall be subjected to DPI/MPI after machining.

6.04.00 Gear Reducer shall be checked for gear ratio, backlash, and contact pattern. No load shop trial run shall be conducted on gear boxes to check for oil leakage, temperature rise, noise and vibration.

6.05.00 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.

6.06.00 All components prior to assembly shall be checked for dimensions.

6.07.00 Function test of Elevator assembly shall be carried out.

6.08.00 All electrical equipments shall be of proven quality.

6.09.00 Galvanized components/parts shall be checked for weight of Zn coating, thickness of coating, uniformity of coating and adhesion test and visual examination as per IS 2633 and IS 2629.

6.10.00 Motor shall be subject to both types and routine tests in accordance with IS-325. In addition, the following tests shall also be carried out :

- a) 20% over speed test for 2 minutes
- b) Vibration measurement
- c) Measurement of noise level as type test
- d) Degree of protection test on both motor enclosure and terminal box as per IS-4691 as type test.

6.11.00 Following items shall be tested as per relevant standard :

- a) Trailing cable
- b) Brake coil
- c) Relay contactors, instruments and controlling equipment.

6.12.00 The control panels shall conform to specific degree of protection and a type test certificate shall be submitted for Owner's approval. In absence of the same to Owner's satisfaction, the bidder shall get first panel of each type tested for specified degree of protection as per IS-2147.

Site Tests

6.13.00 After installation of complete elevator, necessary trial run and tests (No Load, ON Load, Full Load & Over load) shall be carried out by the bidder in the presence of owner to determine that the equipment supplied is satisfactorily installed and commissioned.

6.14.00 It shall also be the responsibility of the bidder to demonstrate the operation of the safety interlocks provided to the full satisfaction of the elevator inspector.

7.00.00 DRAWINGS, DATA, AND INFORMATION

7.01.00 In addition to the Proposal Data Sheets in Volume-III of this specification duly filled up, Bidder shall submit the following drawings/data/information for the elevator along with this offer.

7.02.00 Layout drawing showing principal dimensions of the elevator car in plan and the elevator car and shaft in elevation.

7.03.00 Layout drawing showing the location of various equipment in the elevator machine room.

7.04.00 Complete general arrangement drawing of the elevators and its support structure showing all landing levels and enclosures.

7.05.00 Electrical Control Schematics.



**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 7.06.00 Write-up, description and illustrative pamphlets on various components of the elevator and its control, interlock and safety devices.
- 7.07.00 Detailed drawing of mast including fixing details of mast sections on the chimney wall for stack elevator.
- 7.08.00 Foundation details and loading.
- 7.09.00 Load on elevator columns.
- 7.10.00 Layout of conduits, conductors, cables etc.
- 7.11.00 Other drawings, data sheets and literature as necessary.
- 7.12.00 Instruction manual for erection, testing and commissioning.





ANNEXURE-I

DATA SPECIFICATION SHEET

1.	Location of Elevator	:	Stack / Chimney
2.	Type of Service	:	Passengers-cum-Goods
3.	No. of Elevators (no.)	:	One (1)
4.	Type of Elevator	:	Rack and Pinion Type, Vertical Elevator
5.	Carrying Capacity	:	400 Kg (Minimum)
6.	Total Height of Chimney	:	150 M
7.	Drive Motors (AC)	:	One (1) No.
8.	Total travel	:	~~150 M~~ Refer Data sheet-page no. 5 of 5
9.	Entrance	:	1 No.
10.	Method of Control	:	Semi-Automatic
11.	Cab floor	:	Skid Resistance Chequered Pate/GRP plywood
12.	Cab Floor Size	:	1100 mm x1000 mm (minimum)
13.	No of landings	Refer Data sheet-page no. 5 of 5	~~* Minimum 5 Nos. [EL 1.2M, 40.0 M, 80.0 M, 120.0 M, 135.0 M (to be finalized by the bidder during the course of detail engineering)] bidder to provide landing for all internal/external platform levels.~~
14.	Operating Speed	:	40 m / min (approx.)
15.	Power Supply	:	415V, 3 Phase, 50Hz, 4 wire(solidly grounded), dual power source arrangement shall be provided.
16.	Roller Guides for Cage Frame:		At least six (6)
17.	Other Requirements	:	1. Plant telephone communication system shall be extended up to the elevator car. 2. Suitable arrangement shall be provided to intimate unit control room during emergency in the form of audiovisual alarm. 3. Automatic rescue device.





**Tender Specification
for
Chimney**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

18. Car Enclosure : SS construction.

Note:- 1. Top of RCC roof slab is around EL 145 M. Accordingly Bidder to check and confirm the available headroom clearance.
2. Special tools and tackles as required for the maintenance of the elevator shall be included in Contractor's scope of supply.

**ANNEXURE-II
Mandatory Spares**

Sl. No.		
1.	Bearing for Guide Roller	1Set
2.	Bearing for Counter Roller	1Set
3.	Drive Pinion	1No.
4.	Brake (EHT)	1 No.
5.	Brake Centrifugal	1 No.



10.15 Mandatory Spares, Tools & Tackles, Initial Fill, Oil, Lubricants and Consumables

10.15.1 Mandatory Spares:

The Contractor shall supply mandatory spares as listed in the Technical Specification

10.15.2 Tools & Tackles

- i) The Contractor shall supply new set of tools and tackles, instruments and appliances for operation and maintenance of the plant & equipment as per schedule in the Technical Specification
- ii) the Contractor shall include list of special tools and tackles, such number of sets as he may recommend necessary from his own experience.
- iii) The Contractor shall provide ordering specification including the names of suppliers giving sufficient details to enable the Purchaser to procure at a later date when necessary such special tools and tackles instruments and appliances.

10.15.3 Initial Fill, Oil, Lubricants & Consumables

The Contractor shall within the Contract price of the equipment as per Section-3 supply all consumables including oils, lubricants, lining materials, usual stores and small materials and other consumables required for flushing, initial filling up to completion of Trial operation as per Annexure-VIII.

Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate Containers.

- i) Quantities to be supplied shall be adequate to cover also the wastage/ breakage during transportation, storage, handling, construction, erection and commissioning. Should it be found that the quantities supplied are not adequate till the successful completion of trial operation, the Contractor shall supply further quantities within the time schedule and without any extra cost to the Purchaser.
- ii) The Contractor shall also furnish consumption rates of consumables along with estimated annual requirement and ordering specification to enable the Purchaser to procure these in time. The Contractor shall furnish such information not later than twelve months from the date of Letter of Award.
- iii) The Contractor shall also furnish Indian equivalent of imported oils, lubricants, and other consumables along with necessary specifications, drawings, literature etc.



TITLE:

**TECHNICAL SPECIFICATION
STACK ELEVATOR**

SPECIFICATION NO. PE-TS-N53-503-A-001

VOLUME - IIB

SECTION "D"

SUB-SECTION A6

REV. 00

DATE:

Sheet 1 of 7

**SECTION - D
SUB-SECTION – A6**

STACK ELEVATOR

	TECHNICAL SECIFICATION STACK ELEVATOR	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION D	SUB-SECTION A6
		REV. 0	
		Sheet 2 of 7	

1. DESIGN AND CONSTRUCTION

1.1 Stack Elevator - General

1.1.1

The stack elevator including mechanical and electrical components shall be installed outside/inside Single flue/ multi flue chimney. Since chimney is a free standing structure, deflection of chimney top is expected during the normal operation, so the design of the elevator shall be in such a way that the elevator operation will be safe even with the expected maximum deflection of the chimney structure. The stack elevator shall lift a pay load as indicated against rated load as mentioned in Data sheet-A or its nearest as per manufacturer's present standard in addition to the weight of the car and its accessories and shall travel at a rated speed as indicated in the data sheet-A. Travel of the elevator car, number of landings and levels shall be as per Data sheet-A attached to this section.

1.1.2

Stack elevator mechanical and electrical operating devices and trailing cable shall be designed for operation indoors/out door with dusty and high humidity conditions and shall operate equally well in any ambient temperature encountered in the site conditions. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100oC when the elevator is not operating.

1.1.3

Cage earthing shall be done through trailing cable.

1.1.4

Stack elevator shall be attached to the chimney shell using expansion type anchor bolts drilled in to chimney shell. Elevator shall be capable of operating from the ground floor to the top platform with intermediate stops at all platforms. Landing for elevator parking shall be one (1) metre above the stack ground floor. Suitable concrete/brick steps leading to the landing for entry to cabin shall also be provided,

1.1.5

The stack elevator shall be designed in line with recommendations contained in the latest editions of the applicable codes and standards.

1.2 Equipment Specification

1.2.1 Enclosures

i.

A three-sided enclosure with one access door shall be provided at graded level. At each platform landing above graded level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high and one coat of epoxy primer coated. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the Cab is at the landing. Doors shall be bi-parting and swinging type.

ii.

Base of three-sided enclosure shall be securely anchored to the grade level floor slab using expansion type anchors.

1.2.2 Mast

i.

Mast shall be provided in sections approximately 1.52 m in lengths considering of tubular sections and/or structural shapes welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the concrete chimney walls.

1.2.3 Cab

i.

Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.



TECHNICAL SPECIFICATION

STACK ELEVATOR

SPECIFICATION NO. PE-TS-N53-503-A-001

VOLUME II B

SECTION D

SUB-SECTION A6

REV. 0

Sheet 3 of 7

- ii. Cab floor shall be of skid resistant glass fibre reinforced plywood or approved equal. Cab shall be attached to a framed structure and form integral part with the drive mechanism located atop the cab.

Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.

1.2.4 Buffers

- i. Sufficient numbers of buffers of spring loaded/hydraulic type shall be fitted below the cab. The buffers shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment. The number of buffers shall be so fixed as to ensure proper sharing of impact loads by all of them.

1.2.5 Drive unit and safety Device

- i. Drive unit located on the top of the cab shall be complete with Ac squirrel cage induction motor, reduction gear, drive pinion and an over speed governor. Drive unit shall incorporate an electric disc brake and an external manual brake release. The brake on the electric motor will be of the electromagnetic single disc self-adjusting type with the mechanical compression spring being held off by the electromagnet.
- ii. The hoist shall be provided with a centrifugal brake to prevent accidental tripping of safety device when the cage shall be taken to the ground by gravity in case of power failure.

1.2.6 Power and Control

- i. All electrical components furnished with the elevator shall be completely wired, energised and checked. Necessary power distribution arrangement shall be provided by the contractor to feed the electrical power to the elevator.
- ii. All electrical control devices shall be in enclosures. Equipment furnished shall also include the following:
 - a) Momentary contact push button for raise lower control.
 - b) Reversing combination motor starter with a moulded case circuit breaker for the motor. Starter shall be equipped with three thermal overload relays for motor protection. Operating handle for the combination starter circuit breaker shall be accessible from inside the cab and shall also serve as an emergency stop switch.
 - c) Electrical and mechanical interlocks on cab access door and landing level enclosure doors.
 - d) Over travel protection, emergency stop push button, over speed governors.
 - e) All electrical and mechanical interlocks on cab access door and landing level enclosure doors, phase reversal protection shall be provided.
 - f) An alarm push button shall be provided in the cage connected to a battery-operated alarm at the elevator base. Simultaneous alarm shall also sound at the plant control room in the event of any fault in the stack elevator for which one potential free contact shall be provided in each elevator for audiovisual alarm in PCR for "Stack Elevator fault" indication.
 - g) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.

	TECHNICAL SECIFICATION STACK ELEVATOR	SPECIFICATION NO.PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION D	SUB-SECTION A6
		REV. 0	
		Sheet 4 of 7	

h) Continuous duty electric torque motor recoil cable reels as required to maintain electrical power service to all elevator electrical components throughout the limits of travel.

i) One auxiliary panel shall be furnished and mounted on the grade level enclosure. Panel shall be equipped with a main 'ON-OFF' isolating switch, main contactor, relays, control transformer and fuses, tone frequency transfer, terminal blocks and all other accessories required for normal operation of the elevator.

j) One main control panel shall be furnished and mounted on the top of the cab. Panel shall be equipped with necessary, equipped like rectifier, battery, charger, tone frequency receiver, contactors, MCBs, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.

k) Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling. Degree of protection of the control cabinets shall be IP-52 as per IS:2147. Control cabinets shall be provided with hinged door(s) with padlocking arrangement. All doors, removable covers and plates shall be gasket all around with neoprene gaskets, louvers, when provided, shall have screeners and filters. The screens shall be of fine wire mesh made of brass or GI wire. Suitable cable gland plate shall be supplied fitted on to this gland plate. All cable glands shall be screwed on type and made of brass.

l) Each motor to be controlled from the control cabinet shall be provided with 3 pole isolating switch. HRC fuses, contactors of AC4 duty class with thermal overload relays with single phasing preventer and other equipment required for satisfactory control motor. The isolating switch and contractor shall be rated at least 20% more than the connected motor full load current. Motors of 0.2 KW and above shall be rated for 415 V 3 Phase and below 0.2 KW will be 240 V single phase supply.

m) The controllers and resistors for motors shall conform to IS-8544 (latest edition) and IS-2959 (latest edition) and shall be continuously rated for 150% full load current of the motor. Switches shall be hand operated, air breaker heavy duty, quick make, quick break type conforming to IS-4064. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal / abnormal conditions such as full load, overload, locked rotor, short circuit. The incoming power supply isolating switch shall be inter-locked with the control cabinet door so as to prevent opening of the door when the switch is closed. Device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

n) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 KA. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive without danger of contact with live metal.

o) Contractor shall provide dry type transformers with class B insulation for control power supply, lighting and space heating. Control supply will be 240 V AC.

	TECHNICAL SECIFICATION STACK ELEVATOR	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION D	SUB-SECTION A6
		REV. 0	
		Sheet 5 of 7	

Transformer for control supply shall be provided with a control tap at 110 V, which will be earthed. Power and control supply to individual drives and users shall be distributed with separate isolating switches and primary and secondary fuses.

p) All push buttons shall be of push to actuate type having 2 “NO” and 2 “NC” self reset contacts. They shall be provided with integral escutcheon on plate engraved with their functions. Push button contacts shall be rated for 5 Amp at 415 V AC and 1 Amp. Inductive breaking at 250 V, DC. Mushroom type emergency push button to open the main contactor shall be provided in the operator’s cabin and two on the bridge platform within easy reach indicating lamps shall be of the filament type and low watt consumption lamps shall be provided with series resistors.

q) Strip type space heaters of adequate capacity shall be provided inside in each cabinet.

r) Control cabinets shall be supplied completely wired. All wiring shall be carried out with 650 V grade PVC insulated, stranded conductors. Power circuits shall be wired with stranded aluminum conductors of adequate sizes to suit the rated circuit shall be wired with stranded copper conductors of sizes not small than 1.5 Sq.mm. Control circuits shall be isolated from power circuits.

s) Cab shall be controlled by a semi-automatic floor selection control system. Cab shall be furnished with 240 Volt grounding type receptacle, emergency alarm push button with a normally open contact rated 0.5 ampere at 220 VDC volts, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Cable guides shall be installed at every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level and the main control panel on the cab. Will be provided with the tone frequency receiver. However, control and interlocks from the landings shall be connected to the auxiliary panels located at ground level through fixed armoured cables. The power and control cables and training power cables shall be FRLS type.

t) Each landing assembly shall include a limit switch for door interlock and push button control station installed and wired to a landing junction box.

u) Cable trolley with cable guides for recoil of cable on to cable reel to maintain electrical power service to all elevator components through out the limits of travel.

v) Contractor shall furnish, install, and connect a system equipment ground to the Owner’s existing chimney ground system. System equipment ground shall electrically connect panels and junction boxes, which contain electrical devices, motors, and elevator platforms and support structure. Raceway system shall not be considered as an equipment ground.

w) All enclosures containing electrical devices shall be provided with 240 Volt, single-phase space heaters with adjustable thermostat control.

x) All power cables and race way shall be furnished and installed by the Contractor for interconnection of the main control panel, auxiliary panel and landing junction boxes etc. Conductors included in the cable shall be as required to energise all electrical equipment furnished with the elevator. Transmission of

	TECHNICAL SECIFICATION STACK ELEVATOR	SPECIFICATION NO. PE-TS-N53-503-A-001	
		VOLUME II B	
		SECTION D	SUB-SECTION A6
		REV. 0	
		Sheet 6 of 7	

alarm signals is done by means of tone frequency equipment. Hence communication conductors are not required.

1.2.7 Electric Motor

- i. Elevator drive motor shall be squirrel-cage induction type designed and fabricated to conform to the requirements indicated below.
- ii. Motor shall be designed for operation at the required speed: 415 Volts, 3 phase, 50 hertz. And shall be suitable for full voltage starting, S4 duty class as per IS-4722 with CDF of 25% and maximum number of 120 starts per hour in 55 Deg. C ambient temperature. Motor shall be tested at the factory to determine that it is free from electrical or mechanical defects.

1.2.8 Raceway

- i. General
 - a) Complete raceway system for the elevator shall be furnished and installed in accordance with this section and the Contractor’s shop drawings as reviewed and accepted by the Engineer-in-Charge. The Contractor shall provide drawings for acceptance showing the routing of conduit and wiring for the control circuits associated with the elevator.
 - b) Raceway system is defined to include conduit and all related materials and devices required to support, secure and provide a complete system for support and protection of electrical cable and wiring.
- ii. Materials
 - a) Raceway shall be rigid galvanized steel conduit, provided in accordance with IS-1653 (latest edition).
 - b) Steel conduit, couplings, and elbows shall be hot-dip galvanized rigid mild steel. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. Thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage. Flexible conduits shall be plastic jacketed, liquid tight galvanized steel.
 - c) Galvanized iron or galvanized cast steel fittings shall be used with galvanized steel conduit. Fittings installed outdoors or in damp locations shall be sealed and gasketted. Outdoor fittings shall be of heavy cast construction.

1.2.9 PVC Insulated FRLS Cable

- i. Materials
 - a) Electrical part of this specification shall be referred for FRLS cable. Unless specified otherwise, Contractor shall submit to the Engineer-in-Charge four copies of the manufacturer’s test report on each cable furnished. Conductor accessories including terminal materials like glands, lugs etc. makers, tying materials and cable support shall be furnished and installed. Wire termination materials for conductors 10 Sq. mm and larger shall be pressure or bolted type. Terminals for conductors smaller than 10 Sq. mm shall be an insulated pressure connection in the shape of a ring.
- ii. Installation



TECHNICAL SECIFICATION

STACK ELEVATOR

SPECIFICATION NO. PE-TS-N53-503-A-001

VOLUME II B

SECTION D

SUB-SECTION A6

REV. 0

Sheet 7 of 7

- a) Power and control cable shall be routed as required by the drawings. Cables pulled into the wrong conduit or cut too short shall be replaced. Cables removed from one conduit shall not be installed in another conduit.

1.2.10 Earthing

i. General

- a) Earthing system furnished and installed and include a complete earthing system for the elevator. Earthing equipment and materials shall be furnished and installed in accordance with the reference codes and standards these specifications and the contractor's shop drawings as reviewed and accepted by the Engineer-in-Charge.

ii. Materials

- a) The earthing of all electrical items being supplied by the Bidder shall be in his scope. For earthing the various equipment, conductor sizes shall be as listed below:

- MCCs Motor above 90 KW : 50 x 6 Sq.mm G.I. flat
- Motors above 30 KW, upto 75 KW and lighting panel/ control panels/auxiliary panels : 25 x 6 Sq. mm G.I. flat
- Motor above 5 KW upto 30 KW : 25 x 3 mm G.I. flat
- Motors upto 5 KW and misc. : 8 SWG GI wire
- Small item like conduits,
- Junction boxes etc..

	Title		Spec. No.: PE-TS-N53-503-A-001	
	STACK ELEVATOR		Volume III	SUB SECTION A6
	DATA SHEET 'B'		Sheet 1 of 11	

SUB-SECTION - A6

STACK ELEVATORS

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	2	of	11

1.01.00 ELEVATOR PARTICULARS

- i) Load Carrying Capacity in Kg
- ii) Type of loading for which the stack elevator is designed
- iii) Type of stack elevator
- iv) Rated Load in Kg
- v) Speed in metre/minute
- vi) Chimney height in metre
- vii) Total travel height in metre
- viii) No. of floors to be served
- ix) Elevations of the floors to be served
- x) Method of control
- xi) Details of indicators and control
- xii) Weight of cab complete without load in Kg
- xiii) Weight of hoist cab in Kg
- xiv) Efficiency of Elevator

1.02.00 GROUND ENCLOSURE

- i) Size of the enclosure
(Length x breadth x height)
- ii) Material of construction
- iii) Size of landing entrance
- iv) Method of door operation
- v) Electrical & mechanical interlocking
Of the door provided.
- vi) Method of fixing enclosure to chimney
- vii) Any other details not covered above

1.03.00 LANDING ENCLOSURES

- viii) Size of the enclosure

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	3	of	11

(Length x breadth x height)

- ix) Material of construction
- x) Size of landing entrance
- xi) Method of door operation
- xii) Electrical & mechanical interlocking
Of the door provided.
- xiii) Method of fixing enclosure
- xiv) Any other details not covered above

1.04.00 MAST

- i) Material of mast
- ii) Section of mast
- iii) Size of each piece of mast
- iv) Method of fixing of mast
- v) Type of mast

1.05.0 CAB

- i) Internal size
(Length x breadth x height)
- ii) Material of construction
- iii) Type of floor
- iv) Size of the cab door
- v) Method of operation of cab door
- vi) Electrical & mechanical interlocking provided
- vii) Escape hatch, electrically interlocked
- viii) Guide roller and safety hooks provided
- ix) Arrangement of light/fan inside the cab.
- x) Indicators & controls inside the cab.

1.06.00 ELEVATOR DRIVE UNIT

- i) Location of drive unit
- ii) Name of components of drive unit

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	4	of	11

1.07.00 DETAILS OF ELECTRIC MOTOR

- i) Manufacturer
- ii) Equipment driven by motor
- iii) Type
- iv) Frame size, type & designation
- v) Maximum load considered for
Sizing of motor
- vi) Margin considered for sizing motor
- vii) Rated power in KW
- viii) Service factor
- ix) Speed in rpm
- x) Rated voltage in V
- xi) Current at rated voltage
 - Full load
 - Locked rotor
- xii) Insulation class
- xiii) Type of bearing and type of lubricant
- xiv) Space heater rating
- xv) Duration considered for specified
Ambient temperature
- xvi) Applicable standard to which motor conforms
- xvii) Degree of protection
- xviii) Efficiency at rated output
- xix) Power factor
- xx) Type of mounting

1.08.00 DETAILS OF REDUCTION GEAR

- i) Make

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	5	of	11

- ii) Material of the gears and hardness in BHN
- iii) Type of gear
- iv) Gear ratio
- v) Gear power transmitted
- vi) Input and output speed

1.09.0 DETAILS OF DRIVE AND PINION

- i) Material
- ii) Hardness
- iii) Fixing arrangement

1.10.0 DETAILS OF RACK

- i) Material
- ii) Hardness
- iii) Fixing arrangement

1.11.00 SAFETY DEVICE

- i) Make
- ii) Type of safety device
- iii) Speed at which the safety device
Come into action
- iv) Method operation
- v) Other details
- vi) Remote control for testing
The safety device

1.12.00 BRAKES

- i) Manufacturer
- ii) Types of brakes provided
- iii) Method of operation
- iv) Interlocking if any
- v) Electromagnetic brake and external
Manual brake release

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	6	of	11

vi) Degree of protection

1.13.00 CENTRIFUGAL BRAKE

- i) Make
- ii) Details
- iii) Remote control for testing
The safety device provided.
- iv) Any other details of drive unit
Not covered above.

1.14.00 BUFFERS

- i) No. and location of the buffers provided
- ii) Type of buffers
- iii) If the buffers are spring type
Furnish the following:

- Diameter of the spring in mm
- Max. Compression under extreme cond.
- No. of spring coil
- Sectional dimension
- Material of spring
- Compression /unit load

1.15.00 POWER CABLES

Fixed

Trailing

- i) Manufacturer
- ii) Type and material
- iii) Rated voltage
- iv) Rated current

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	7	of	11

- v) Type of insulation
- vi) No. of strands
- vii) No. of cores
- viii) Short circuit current rating
- ix) Resistance per 1000 metres
- x) Applicable standards

1.16.00 CONTROL CABLES

- xi) Manufacturer
- xii) Type and material
- xiii) Rated voltage
- xiv) Rated current
- xv) Type of insulation
- xvi) No. of strands
- xvii) No. of cores
- xviii) Short circuit current rating
- xix) Resistance per 1000 metres
- xx) Applicable standards

1.17.00 CONDUITS/ACCESSORIES AND FITTINGS

- i) Material
- ii) Manufacturer
- iii) Applicable standard

1.18.00 CONTACTORS

- i) Make
- ii) Type
- iii) Applicable standards
- iv) No. of poles

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	8	of	11

- v) Rated voltage
- vi) Rated frequency
- vii) Rated current
- viii) Closing coil
 - Rated voltage
 - Current consumption
 - Power consumption in KW
 - Insulation class for electromagnet
- ix) Rated duty
 - Rated insulation category
 - No. of operations per hour
 - Rated breaking capacity
 - Rated making capacity
 - Short time rating in sec
- ix) Limits of operation
 - Supply voltage variations (%)
 - Supply frequency variations (%)
 - Drop out voltage (%)
 - Min. pick up voltage (%)
- x) Thermal overload relay setting range available
- xi) Auxiliary contacts
 - Numbers
 - Current rating (Make and break)
- xi) Rated utilization category as per IS 2459
- xii) Max. recommended back up HRC fuse size

1.19.00 FUSES

- i) Make
- ii) Type
- iii) Continuous current

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	9	of	11

- iv) Rated voltage
- v) Rated frequency
- vi) Rupturing capacity
- vii) Mounting details
- viii) Fixing and removing arrangement
- ix) Visual indication for fuses
- x) Applicable standards

1.20.00 INDICATING LAMPS

- i) Make
- ii) Type
- iii) Rated voltage
- iv) Rated power consumption in Watt
- v) Permissible voltage variation
- vi) Series resistance provided

1.21.00 PUSH BUTTONS

- i) Make
- ii) Type
- iii) Rating
 - Voltage
 - Continuous current
- iv) No. of aux. Contacts
 - Normally open
 - Normally closed
- v) Contact rating
- vi) Colours
- vii) Mounting arrangement

1.22.00 OVER TRAVEL LIMIT SWITCH

- i) Make
- ii) Type
- iii) Material of contacts

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	10	of	11

- iv) Contact rating
- v) Numbers furnished

1.23.00 CONTROL TRANSFORMER

- i) Make
- ii) Type
- iii) Output rating (VA)
- iv) Ratio
- v) Class of insulation
- vi) Max. temp rise of winding over
Specified ambient temperature.
- vii) One minute power frequency test voltage
- viii) Applicable standards

1.24.00 CIRCUIT BREAKER AND ISOLATOR

- i) Make
- ii) Type
- iii) Current rating in amps
- iv) Interruption duty
- v) Max. breaking capacity
- vi) Operating voltage of tripping and closing coils
- vii) Max. permissible variation of operating voltage

1.25.00 RACEWAY

- i) Raceway as per specification
- ii) Material of
 - Indoor fittings
 - Outdoor fittings
 - Raceway support
 - Junction boxes

1.26.0 EARTHING

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	Title		Spec. No.: PE-TS-N53-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	11	of	11

- i) Earthing conductor
 - Size
 - Material
- ii) Material of earthing cable
- iii) Clamps. Bolts, washers, nuts and another Hardware of iron steel are galvanized.

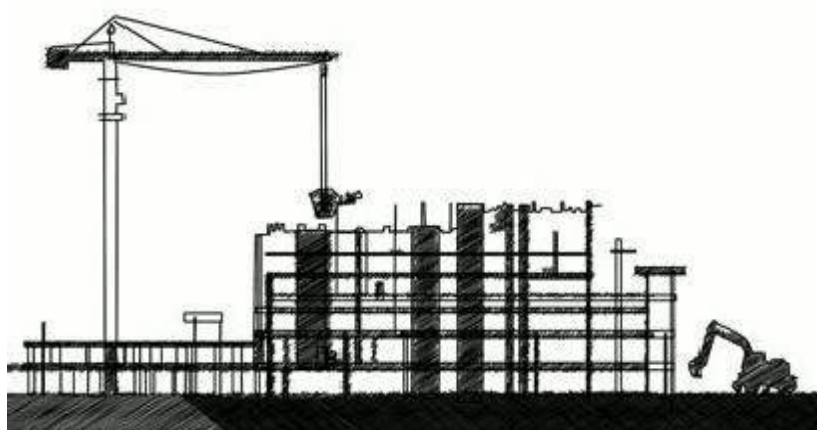
1.27.00 MOTOR STARTER

- i) Make & Size
- ii) Rating]
- iii) Mechanically latched type
- iv) Single phase prevention feature provided
- v) Degree of protection

1.28.00 DETAILS OF CONTROL PANELS

- i) No. of panels
- ii) Type of enclosures (Degree of protection)
- iii) Thickness of sheet metal
- iv) Painting
 - Colour
 - Finish
- v) Cable entry
- vi) Manufacturer

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						



HEALTH, SAFETY and ENVIRONMENT PLAN

for

**SITE
OPERATIONS**

by

**SUB-
CONTRACTORS**

POWER SECTOR

HSE PLAN FOR SITE OPERATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START	SIGNING OF MOU	
	Agree to comply to HSE requirement- Statutory and BHEL’s	
PLAN	HSE ORGANISATION	
	Manpower 1 (one) safety officer for every 500 workers or part thereof 1(one) safety-steward/ supervisor for every 100 workers Qualification As per Cl. 7.1	HSE Roles and responsibilities - Site In-charge- As per clause 7.2.1 - Safety officer- As per clause 7.2.2
	HSE Planning for Man, Machinery/Equipment/Tools & Tackles	
PROVIDE	HSE INFRASTRUCTURE	
	- PPEs - Drinking Water - Washing Facilities - Latrines and Urinals - Provision of shelter for rest - Medical facilities	- Canteen facilities - Labour Colony - Emergency Vehicle - Pest Control - Scrapyard - Illumination
TRAIN	HSE TRAINING , AWARENESS & PROMOTION	
	Training - Induction training - Height work and other critical areas - Tool Box talk & Pep Talk	Awareness & Promotion - Signage - Poster - Banner - Competition - Awards
COMMUNICATE	HSE COMMUNICATION	
	Incident Reporting - Accident- Fatal & Major - Property damage - Near Miss	Event Reporting - Celebrations - Training - Medical camp

EXECUTE SAFELY

OPERATIONAL CONTROL PROCEDURES

PERMIT TO WORK

Height work (above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, excavation (More than 4 metres)

SAFETY DURING WORK EXECUTION

• Welding • Rigging • Cylinder- storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works	• Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance

HOUSE KEEPING

WASTE MANGEMENT

TRAFFIC MANAGEMENT

ENVIRONMENTAL CONTROL

EMERGENCY PREPAREDNESS AND RESPONSE PLAN

CHECKS

HSE AUDITS & INSPECTION

• Daily Checks • Inspection of PPEs • Inspection of T& Ps • Inspection of Cranes & Winches	• Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc.

HSE PERFORMANCE EVALUATION PARAMETERS

NON CONFORMANCE

PENALTY for NON CONFORMANCE

Refer Clause 16

Incremental penalty

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS		Doc no.: HSEP: 14
	POWER SECTOR		REV: 01
			Date: 20.01.2020

REVISION HISTORY SHEET

Date	Revision No.	Details of Changes	Reason	Prepared	Reviewed	Approved
12.08.2014	00	First Issue	First Issue	S. B. Jayant, Dy Manager- FQA & Safety	A. K. Sinha, GM-FQA & Safety	Anuj Bhatnagar, ED-FQA & Safety
20.01.2020	01	Formats added: HSEP:14-F30 – Monthly HSE Planning & Review (Page 11, Clause 8.0 - updated) HSEP:14-F13E-Excavation Inspection Format (part of F30)) HSEP:14-F32B – Job Safety Analysis Format (part of F30) HSEP:14-F31A – Daily HSE Reporting (Page 18, Clause 10.3 – added) HSEP:14-F33 – HSE Performance Evaluation (Page 31, Clause 13 – revised)	IOM No. PSHQHSE/M ONREP/02 Dated 08-Jan-2020	Rohit Kumar	Santosh Nair, GM (MSX & HSE)	



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 1 of 43

Sr. No.	Description	Page No.
1.0	PURPOSE	4
2.0	SCOPE	4
3.0	OBJECTIVES AND TARGETS	4
4.0	HEALTH, SAFETY & ENVIRONMENT POLICY	5
5.0	MEMORANDUM OF UNDERSTANDING	6
6.0	TERMS & DEFINITIONS	7
7.0	HSE ORGANIZATION	8
7.1	QUALIFICATION FOR HSE PERSONNEL	8
7.2	RESPONSIBILITIES	9
8.0	PLANNING BY SUBCONTRACTOR	11
8.1	MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS	11
8.2	MOBILISATION OF MANPOWER BY SUBCONTRACTOR	11
8.3	PROVISION OF PPEs	12
8.4	ARRANGEMENT OF INFRASTRUCTURE	13
9.0	HSE TRAINING & AWARENESS	16
9.1	HSE INDUCTION TRAINING	16
9.2	HSE TOOLBOX TALK	17
9.3	TRAINING ON HEIGHT WORK	17
9.4	HSE TRAINING DURING PROJECT EXECUTION	17



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 2 of 43

9.5	HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC	18
10.0	HSE COMMUNICATION	18
10.1	INCIDENT REPORTING	18
10.2	HSE EVENT REPORTING	18
11.0	OPERATIONAL CONTROL	19
11.1	HSE ACTIVITIES	19
11.2	WORK PERMIT SYSTEM	20
11.3	SAFETY DURING WORK EXECUTION	20
11.4	ENVIRONMENTAL CONTROL	24
11.5	HOUSEKEEPING	24
11.6	WASTE MANAGEMENT	25
11.7	TRAFFIC MANAGEMENT SYSTEM	26
11.8	EMERGENCY PREPAREDNESS AND RESPONSE	28
12.0	HSE INSPECTION	29
12.1	DAILY HSE CHECKS	29
12.2	INSPECTION OF PPE	29
12.3	INSPECTION OF T&Ps	30
12.4	INSPECTION OF CRANES AND WINCHES	30
12.5	INSPECTION ON HEIGHT WORKING	30
12.6	INSPECTION ON WELDING AND GAS CUTTING OPERATION	30



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: **3 of 43**

12.7	INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES	31
12.8	INSPECTION OF ELEVATOR	31
12.9	INSPECTION OF EXCAVATION ACTIVITIES	31
13.0	HSE PERFORMANCE	31
14.0	HSE PENALTIES	32
15.0	OTHER REQUIREMENTS	32
16.0	NON COMPLIANCE	33
17.0	HSE AUDIT/INSPECTION	34
18.0	MONTHLY HSE REVIEW MEETING	34
19.0	FORMATS USED	34
20.0	Annexures	36



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 4 of 43

1.0 PURPOSE

- 1.1** The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.
- 1.2** This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.
- 1.3** Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.
- 1.4** In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 5 of 43

HSE TARGETS

EXPLOSION	ZERO
FATALITY	ZERO
LOST TIME INJURY	ZERO
FIRE	ZERO
VEHICLE INCIDENTS	ZERO
ENVIRONMENTAL INCIDENTS	ZERO

4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY

Health, Safety & Environment Policy of BHEL

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

sd/-

CMD, BHEL

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 6 of 43

5.0 MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector _____ Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s _____ do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/s _____ shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to all workers and supervisors for compliance.

In addition to this, M/S _____ shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s _____ shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

Signed by authorized representative of M/s -----

Name :

Place & Date:



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 7 of 43

6.0 TERMS AND DEFINITIONS

6.1 DEFINITIONS

6.1.1 INCIDENT

Work- related or natural event(s) in which an injury, or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

6.1.2 NEAR MISS

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

6.1.3 MAN-HOURS WORKED

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labours. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

6.1.4 FIRST AID CASES

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

6.1.5 LOST TIME INJURY

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6.1.6 MEDICAL CASES

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

Non-Reportable Cases:

An incident, where the injured person is given medical help and discharged for work without counting any lost time.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 8 of 43

Reportable Cases:

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

Injury Cases:

These are covered under the heading of non-reportable cases. In these cases the incident caused injury to the person, but he still continues his duty.

6.1.8 TOTAL REPORTABLE FREQUENCY RATE

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\frac{\text{Number of Reportable LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

6.1.9 SEVERITY RATE

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI} \times 1000}{\text{Average number of manpower deployed}}$$

7.0 HSE ORGANISATION

Number of safety officers:

The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

Deployment: The subcontractor should deploy sufficient safety officers and safety-steward/Safety-supervisor, as per requirement given above, since initial stage and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty of Rs.30,000/- per man month for the delayed period.

7.1 QUALIFICATION FOR HSE PERSONNEL

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 9 of 43

POWER SECTOR

2	Safety-Steward/ Supervisor	Safety- Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years

7.2 RESPONSIBILITIES

7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR

- ☐ Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the site management.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mockdrill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HQ/External /Customer HSE audits.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 10 of 43

- ☐ Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the worksite.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site and labour colony.
- Shall ensure adequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- ☐ Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available.

7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HQ on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- ☐ Apprise PS– Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 11 of 43

8.0 PLANNING BY SUBCONTRACTOR

Monthly planning and review of HSE activities shall be carried out by subcontractor as per format No. HSEP:14-F30 jointly along with BHEL.

8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable.
- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:
 - o Mobile cranes.
 - o Side Booms.
 - o Forklifts.
 - o Grinding machine.
 - o Drilling machine.
 - o Air compressors.
 - o Welding machine.
 - o Generator sets.
 - o Dump Trucks.
 - o Excavators.
 - o Dozers
 - o Grit Blasting Equipment.
 - o Hand tools.
- Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.

8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 12 of 43

8.3 PROVISION OF PPEs

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

Relevant is-codes for personal protection

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 6994 – 1973 (Part-I)	Industrial Safety Gloves (Leather & Cotton Gloves).
IS: 1989 – 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 6519 – 1971	Code of practice for selections care and repair of Safety footwear.
IS: 11226 – 1985	Leather Safety footwear having direct molding sole.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 – 1983	Industrial Safety Belts and Harness
IS: 8519 -1977	Guide for selection of industrial Safety equipment for body protection
IS: 9473-2002, 14166-1994, 14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 13 of 43

- Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public
- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmet and any other PPEs as deemed appropriate for the area of work.

Colour scheme for Helmets:

1. Workmen: Yellow
 2. Safety staff: Green or white with green band
 3. Electrician: Red
 4. Others including visitors: White
- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced.
 - The issuing agency shall maintain register for issue and receipt of PPEs.
 - The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
 - The body harnesses shall be serial numbered.

8.4 ARRANGEMENT OF INFRASTRUCTURE

8.4.1 DRINKING WATER

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as "Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next due date.
- Potability of water should be tested as per IS10500 at least once in a year.

8.4.2 WASHING FACILITIES

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

8.4.3 LATRINES AND URINALS

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- Separate facilities shall be provided for the use of male and female worker if any.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 14 of 43

8.4.4 PROVISION OF SHELTER DURING REST

Proper Shed & Shelter shall be provided for rest during break

8.4.5 MEDICAL FACILITIES

8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. The medical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste –Management and Handling Rules, 1998)

8.4.5.2 FIRST AIDER

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)

- The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:14-F01
- The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)

The persons engaged at the site shall undergo health checkup as per the format no. HSEP:14-F02 before induction. The persons engaged in the following works shall undergo health checkup at least once in a year:

- a. Height workers
- b. Drivers/crane operators/riggers



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 15 of 43

- c. Confined space workers
- d. Shot/sand blaster
- e. Welding and NDE personnel

8.4.6 PROVISION OF CANTEEN FACILITY

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

8.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY

- ☐ The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labour colony.
- ☐ Regular housekeeping of the labour colony shall be ensured.
- ☐ Proper sanitation and hygienic conditions to be maintained.
- ☐ Drinking water and electricity to be provided at the labour colony.
- ☐ Bathing/ washing bay
- ☐ Room ventilation and electrification.

8.4.8 PROVISION OF EMERGENCY VEHICLE

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle any emergency

8.4.9 PEST CONTROL

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

8.4.10 SCRAPYARD

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

8.4.11 ILLUMINATION

- The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II). Some recommended values are given below:



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 16 of 43

POWER SECTOR

S. No.	Location	Illumination (Lux)
A. Construction Area		
1.	Outdoor areas like store yards, entrance and exit roads	20
2.	Platforms	50
3.	Entrances, corridors and stairs	100
4.	General illumination of work area	150
5.	Rough work like fabrication, assembly of major items	150
6.	Medium work like assembly of small machined parts	300
	rough measurements etc.	
7.	Fine work like precision assembly, precision	700
	measurements etc.	
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
B. Office		
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

9.0 HSE TRAINING& AWARENESS

9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules.
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 17 of 43

- Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:14-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work. The agenda shall consist of the followings:
 - o Details of the job being intended for immediate execution.
 - o The relevant hazards and risks involved in executing the job and their control and mitigating measures.
 - o Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
 - o Recent non-compliances observed.
 - o Appreciation of good work done by any person.
 - o Any doubt clearing session at the end.
- Record of Tool box talk shall be maintained as per format no. HSEP:14-F04
- Tool box talk to be conducted at least once a week for the specific work.

9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:
 - o Hazards identification and risk analysis (HIRA)
 - o Work Permit System
 - o Incident investigation and reporting
 - o Fire fighting
 - o First aid
 - o Fire-warden training
 - o EMS and OHSMS
 - o T & Ps fitness and operation



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 18 of 43

- o Electrical safety
- o Welding, NDE & Radiological safety
- o Storage, preservation & material handling.
- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC

9.5.1 Display of HSE posters and banners

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

9.5.2 Display of HSE signage

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

9.5.3 Competition on HSE and award

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

9.5.4 HSE awareness programme

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

10.0 HSE COMMUNICATION

10.1 INCIDENT REPORTING

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. (Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

10.2 HSE EVENT REPORTING

- Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

10.3 DAILY HSE ACTIVITY REPORTING

Daily HSE activities shall be reported by subcontractor to BHEL as per Format No. HSEP:14-F31A



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

POWER SECTOR

Page: 19 of 43

11.0 OPERATIONAL CONTROL

All applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCPs is given below. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCPs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Power Sector Regional HQ, or available in downloadable format in the website, which may be refereed by subcontractor, if they so desire.

LIST OF OCPs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DG set	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hotwell / deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronization		

11.1 HSE ACTIVITIES

HSE activities shall be conducted at site based on the HSEMSM developed by Power Sector and issued to site by Regions.

While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

- 1) HSE Procedure for Register of OHS Hazards and Risks
- 2) HSE Procedure for Register of Environmental Aspects and Impacts
- 3) HSE Procedure for Register of Regulations



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 20 of 43

- 4) Operational Control Procedures
- 5) HSE Procedure for Emergency Preparedness and Response Plan
- 6) Contract documents

11.2 WORK PERMIT SYSTEM

- ☐ The following activities shall come under Work Permit System
 - a. Height working above 2 metres
 - b. Hot working at height
 - c. Confined space
 - d. Radiography
 - e. Excavation more than 4 meter depth
 - f. Heavy lifting above 50 tonRefer Annexure 05 for Work permit formats.
- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- ☐ Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- ☐ Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- ☐ Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

11.3.2 RIGGING

Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.

11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP

Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 21 of 43

When cylinders are transported by powered vehicle they shall be secured in a vertical position.

11.3.4 DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
- All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

11.3.5 T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL..Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

11.3.6 CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 22 of 43

- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist" and the report is to be submitted to BHEL safety officer
- Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

11.3.8 FIRE SAFETY

- Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- Emergency contacts nos must be displayed at prominent locations
- Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.

11.3.9 SCAFFOLDING

- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders.
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than $\frac{1}{4}$ horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from savor, from swaying, from the building or structure.

11.3.10 WORK AT HEIGHT:

- Guardrails and toe-board/barricades and sound platform conforming to IS:4912-1978 should be provided.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 23 of 43

- Wherever necessary, life-line (pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should be provided.
- Safety Net as per IS:11057:1984 should be used extensively for prevention/ arrest of men and materials falling from height. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
- Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.
- Monkey Ladder should be properly made and fitted with cages.
- Jhoola should be made with angles and flats and tested like any lifting tools before use.
- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.
- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- Empty drums must not be used.
- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor. Rope ladder should be discouraged.

11.3.11 WORKING PLATFORM

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least ¼" for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

11.3.14 LIFTING SAFETY

- It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 24 of 43

- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractor by engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

11.3.15 HOISTING APPLIANCE

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

11.4 ENVIRONMENTAL CONTROL

Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.

Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).

In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique

All subcontractors shall be responsible for the cleanliness of their own areas.

The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable & practicable precautions can be taken to protect other persons who may be affected.

It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.

The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

11.5 HOUSEKEEPING

- Keeping the work area clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings has to be done by



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 25 of 43

subcontractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. Sufficient waste bins shall be provided at
- Different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

11.6 WASTE MANAGEMENT

Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.

11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 26 of 43

11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

11.7 TRAFFIC MANAGEMENT SYSTEM

11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.
- Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- Speed limits shall be clearly displayed. Speed ramps preceded by a warning signs or marker are necessary.
- The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 27 of 43

- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

11.7.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- o A high level of stability.
- o A safe means of access/egress.
- o Suitable and effective service and parking brakes.
- o Windscreens with wipers and external mirrors giving optimum all round visibility.
- o Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- o Provision of seat belts.
- o Guards on dangerous parts.
- o Driver protection - to prevent injury from overturning and from falling objects/materials.
- o Driver protection from adverse weather.
- o No vehicle shall be parked below HT/LT power lines.
- o Valid Pollution Under Control certification for all vehicles



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 28 of 43

11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
 - o Brakes.
 - o Tires.
 - o Steering.
 - o Mirrors.
 - o Windscreen waters.
 - o Wipers.
 - o Warning signals.
 - o Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

11.7.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
 - Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
 - All overhangs shall be made clearly visible and restricted to acceptable limits
 - Load shall be checked before moving off and after traveling a suitable distance.
 - On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.
 - Warning signs shall be displayed during transportation of material.
- All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

11.7.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

11.8 EMERGENCY PREPAREDNESS AND RESPONSE

- Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HQ
- Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- Assembly point shall be earmarked and access to the same from different location shall be shown
- Fire exit shall be identified and pathway shall be clear for emergency escape.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 29 of 43

- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- First aid center shall be developed at site with trained medical personnel and ambulance
- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- Tie up with fire brigade shall be done in case customer is not having fire station.
- Tie up with hospital shall be done in case customer is not having hospital.
- Disaster Management group shall be formed at site
- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats
- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test etc. as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- Personal Safety wears & gear compliance.
- Complying with site safety rules and permit-to-work (PTW).
- Positions and postures of workers.
- Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:14-F06 for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 30 of 43

12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:14-F07 for its healthiness and maintenance.
- The T&Ps which require third party inspection shall be checked for its validity during inspection. The third party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:14-F08

12.4 INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:14-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the I-card.
- The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
 - o Fall arrestor
 - o Lifelines
 - o Safety nets
 - o Fencing and barricading
 - o Warning signage
 - o Covering of opening
 - o Proper scaffolding with access and egress.
 - o Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 31 of 43

- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

12.8 INSPECTION OF ELEVATOR

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.

12.9 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per Format HSEP:14-F13A

13.0 HSE PERFORMANCE

- Contractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site. The HSE compliance shall be based on Online HSE Evaluation System of BHEL as per Format No. HSEP:14-F33.
- BHEL shall reserve the right to use this assessment for evaluating bidder's capacity for future tenders
- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen by the subcontractor.
To decide HSE reward, performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.: HSEP: 14
		REV: 01
	POWER SECTOR	Date: 20.01.2020
		Page: 32 of 43

14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.
- If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHEL shall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: **33 of 43**

- BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

16. NON COMPLIANCE

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

• Legend:-

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: **34 of 43**

17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- HSE checklist (**Annexure 02**) shall be used for carrying out audit/inspection and report shall be submitted to BHEL site management
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed off by site in a time bound manner and reported back the implementation status
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HQs shall be implemented by site and reported to Site management.

18.0 MONTHLY HSE REVIEW MEETING

- ☐ Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE performance. It will also discuss the incidents occurred since previous meeting, its root cause and Corrective action and Preventive action. The agenda is given below:
 - o Implementation of earlier MOM
 - o HSE performance
 - o HSE inspection
 - o HSE audit and CAPA
 - o HSE training
 - o Health check-up camp
 - o HSE planning for the erection and commissioning and installation activities in the coming month
 - o HSE reward and promotional activities
- ☐ The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS, Site Incharge of Subcontractors and HSE officer of Subcontractors.
- ☐ MOM on the discussion will be circulated to the concerned for implementation.

19.0 FORMATS USED (Details available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:14-F01	00
02	Health Check Up	HSEP:14-F02	00
03	HSE Induction Training	HSEP:14-F03	00
04	Tool Box Talk	HSEP:14-F04	00
05	Monthly Site HSE Report	As specified by BHEL	00
06	Inspection of PPE	HSEP:14-F06	00



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

POWER SECTOR

Page: 35 of 43

07	Inspection of T&Ps	HSEP:14-F07	00
08	Status of T&Ps	HSEP:14-F08	00
09	Inspection of Cranes and Winches	HSEP:14-F09	00
10	Inspection on Height Working	HSEP:14-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:14-F11	00
12	Inspection on Electrical Installation	HSEP:14-F12	00
13	Inspection on Elevator	HSEP:14-F13	00
14	HSE Penalty	HSEP:14-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:14-F15	00



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 36 of 43

20.0 ANNEXURES

ANNEXURE 01

As per Contract Labour (Regulation & Abolition Act), Central Rules, 1971,

- (1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

(a) For establishments in which the number of contract labour employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labour exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 37 of 43

(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

(2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 38 of 43

ANNEXURE 02

HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT

PROJECT: _____

SUBCONTRACTOR: _____

DATE : _____

OWNER : _____

INSPECTION BY: _____

Note : write 'NA' wherever the items is not applicable

Item	Y e s	N o	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNEL PROTECTIVE EQUIPMENTS				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landing				
Properly secured				



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 39 of 43

POWER SECTOR

Angle + 70° from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
Others				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: 40 of 43

Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				
Provision of crèches for children.				



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: **41 of 43**

ANNEXURE 03

REFERENCES

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
(1)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	IS:2925 – 1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	IS:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) – 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	IS:3696 (Part I) – 1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002)	Scaffolds and Ladders-Code of Safety
(9)	IS:3786 – 1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	IS:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves – Electricals purposes-Specification
(11)	IS:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	IS: 5983 – 1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	IS:6519 – 1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	IS:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Part I)-1973 (Re affirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	IS:8519 – 1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 : 2011	Flash Back(Flame Arrestor) Specification



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

Doc no.: HSEP: 14

REV: 01

POWER SECTOR

Date: 20.01.2020

Page: **42 of 43**

(18)	IS:8520 – 1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	IS:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	IS:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	IS:11057 – 1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	IS:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 2003)	Safe Use of Cranes-Code of Practice
(24)	IS:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	IS:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored Pressure)-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing



**HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS**

POWER SECTOR

Doc no.: HSEP: 14

REV: 01

Date: 20.01.2020

Page: **43 of 43**

**ANNEXURE 04 : SAFETY FORMATS
&
ANNEXURE 05 : WORK PERMIT FORMATS**

**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:14-F01

REV NO.: 00

PAGE NO. 01 OF 02

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Number of employees on the site: - _____

Sl.No.	Item	No. Available	Remarks
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of Suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:14-F01

REV NO.: 00

PAGE NO. 02 OF 02

Sl.No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmX1 meter) available		
19	No of rolls of adhesive plaster (2 cmX1 meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti-septic solution available		

Signature of Subcontractor's Site I/C:

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:14-F02

REV NO.: 00

PAGE NO. 1 OF 02

Name of Site :	
Name of Sub-Contractor :	
Name of Employee :	

NAME:

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness
Personal History	
EXAMINATION	
OBSERVATION	
<u>General Physical Examination</u>	
Height	:
Weight	:
BMI	:
Built And nourishment	:
Pallor	:
Temperature	:
Chest Expansion	: Inspiration Expansion
Lymph Node Enlargement	:
<u>Ear, Nose, Throat</u>	:
Ear	:
Nose	:
Throat	:

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:14-F02

REV NO.: 00

PAGE NO. 2 OF 02

EXAMINATION	OBSERVATION
<u>Cardiovascular System Examination :</u>	
Inspection :	
Palpation :	Pulse BP
Auscultation (Heart Sounds) :	
<u>Respiratory System :</u>	
Inspection :	Respiratory Rate
Palpation:	
Percussion :	
Auscultation (Breath Sounds) :	
<u>Examination of Abdomen :</u>	
Inspection :	
Palpation :	
Auscultation (Bowel Sounds) :	
Any Other :	
Clinical Impression	

Signature of the examining doctor

**POWER SECTOR****HSE INDUCTION TRAINING**

FORMAT NO: HSEP:14-F03

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training Co-ordinator	

Sl No.	Name	Designation	Organisation	Signature

Signature of Training co-ordinator :

	POWER SECTOR	FORMAT NO: HSEP:14-F04 REV NO.: 00 PAGE NO. 01 OF 01
	TOOL-BOX TALK	

Name of Site :	
Sub-Contractors Name :	
Date :	

Topic	Name of person delivered Tool Box Talk	No. of Participants attended	Remarks

Signature of Site I/C of Subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F06 REV NO.: 00 PAGE NO. 01 OF 01
	PERSONAL PROTECTIVE EQUIPMENTS	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Item	Issued this Month	Nos. Issued up to the Month	Percentage of usage at site
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor :

**POWER SECTOR****INSPECTION OF T&Ps**

FORMAT NO: HSEP:14-F07

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

Sl.No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs / overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Site Safety Officer (BHEL)

Signature-Subcontractor/ Subcontractor's
Safety Officer

	POWER SECTOR	FORMAT NO: HSEP:14-F08 REV NO.: 00 PAGE NO. 01 OF 01
	STATUS OF T&Ps	

Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	Nos. Deployed	Identification No.	Nos. Tested by competent person	Validity of Test Certificate
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor:

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:14-F09

REV NO.: 00

PAGE NO. 01 OF 03

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Crane Reg. No (Make/Model) _____

Name of Driver/Operator _____

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers fully extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:14-F09

REV NO.: 00

PAGE NO. 2 OF 03

Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone other than the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured that the guard does not constitute a hazard by itself?				
8	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:14-F09

REV NO.: 00

PAGE NO. 3 OF 03

Sl. No.	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained to the workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	ACCESS/EGRESS		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding or falling?		
6	Do side rails extend 36" above top landing?		
7	Are built up ladders constructed of sound materials?		

**POWER SECTOR****INSPECTION OF HEIGHT WORKING**

FORMAT NO: HSEP:14-F10

REV NO.: 00

PAGE NO. 02 OF 02

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
8	Are rugs and cleats not over 12" on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	Housekeeping		
1	Walkways, aisles & all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	PPE And Safety Devices		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF WELDING AND GAS
CUTTING**

FORMAT NO: HSEP:14-F11
REV NO.: 00
PAGE NO. 1 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
Sl.no.	Description	Y e s	N o	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly & insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Is the physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Is the electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

**POWER SECTOR****INSPECTION OF WELDING AND GAS
CUTTING**

FORMAT NO: HSEP:14-F11
REV NO.: 00
PAGE NO. 2 OF 02

Gas Cutting				
Sl. no	Description	Yes	No	Remarks
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for O2 and LPG cylinder?			
8	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	% Compliance			

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F12 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF ELECTRICAL INSTALLATION	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	Contents	Yes/No	Remarks
A	Cable		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	DBs/SDBs		
1.	Is earth conductor continued up to DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
C	ELCB		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

**POWER SECTOR****INSPECTION OF ELECTRICAL INSTALLATION**

FORMAT NO: HSEP:14-F12

REV NO.: 00

PAGE NO. 02 OF 02

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
D	Grounding		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	Electrically operated Machines or Accessories.		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF ELEVATOR**

FORMAT NO: HSEP:14-F13

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Sr. No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs/overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Subcontractor/ Subcontractor's
Safety Officer

Signature-Site Safety Officer (BHEL)

	POWER SECTOR	FORMAT NO: HSEP:14-F13E REV NO.: 00 PAGE NO. 01 OF 01
	Inspection of Excavation	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Sl.no.	Description	Yes	No	Remarks
1	Precautions taken for Underground Electrical Cable			
2	Precautions taken for Under / Above ground sewer/ Drinking Water Line			
3	Precautions taken for Underground Telecommunication Line			
4	Precautions taken for Underground Product/Utility Line			
5	Precautions taken for Underground Fire Water Line			
6	Shoring / Shuttering / Sheet piling done to prevent collapse of excavation walls. Strength of Excavation wall ensured at all times			
7	Slope Cutting / Angle Maintained			
8	Hard Barricading & Edge Protection provided			
9	Separate Safe Access for Man and Vehicle			
10	Lighting arrangement			
11	Banksman Provided			
12	Required basic PPEs provided			
13	Excavated soil / Construction Material / equipment kept away from the edge.			
14	First aid in attendance.			
15	Other:			
	Total No of YES			

Signature-Subcontractor/ Subcontractor's Safety Officer

Signature-Site Safety Officer (BHEL)

**POWER SECTOR****HSE PENALTY**

FORMAT NO: HSEP:14-F14

REV NO.: 00

PAGE NO. 1 OF 02

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

Safety Area

SN	Violation of Safety Norms	Fine (in Rs)
01.	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03.	Not wearing safety shoe	200/-*
04.	Not keeping gas cylinders vertically	200/-
05.	Not using flash back arrestors	100/-
06.	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18.	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

Legend: -

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

	POWER SECTOR- HQ	FORMAT NO: HSEP:14-F15 REV NO.: 00 PAGE NO. 01 OF 01
	Incident Report (To be submitted within 24 hours of time of incident)	

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	NAME OF SITE		3	ACTIVITY AREA	
2	SCOPE OF WORK		4	NAME OF CONTRACTOR	
			5	NAME & DESIGNATION OF BHEL ACTIVITY I/C	
6	DATE & TIME OF ACCIDENT		7	DATE RESUMED	
8	NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)				
9	NO. OF MANHOURS LOST BY OTHERS				
10	PERSONAL DETAILS OF INJURED AND / OR DETAILS OF MATERIALS / EQUIPMENT / PROPERTY DAMAGED				
NAME			NAME OF MATERIAL / EQUIPMENT / PROPERTY		
PERIOD OF EMPLOYMENT					
AGE	YRS	SEX	MALE/ FEMALE	ESTIMATED COST	ACTUAL COST
MARITAL STATUS		SINGLE / MARRIED			
OCCUPATION		NATURE OF DAMAGE			
PART OF BODY INJURED					
NATURE OF INJURY					
AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE					
12	PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) CAUSING ACCIDENT INJURY / DAMAGE				
13	DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED)				
ANALYSIS					
14	WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT				
15	WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND / OR CONDITION ?				
16	WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE ?				
	DATE :		SIGNATURE OF SITE HSE COORDINATOR		
17	COMMENTS OF HEAD / SOX				
	DATE:		SIGNATURE OF HEAD/SOX		



POWER SECTOR

Format for Monthly HSE Planning & Review

FORMAT NO: HSEP:14-F30

REV NO.: 00

PAGE NO. 01 OF 3

Note: This is a template and can be modified in consultation with BHEL

Name of the Site		Name of the Subcontractor	
Scope of Work		Date	
PART- A: PLAN OF HSE ACTIVITIES FOR THE MONTH OF.....		PART-B: REVIEW ON	
SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
1	Availability of First Aid Box at Required Places and Inspection thereof as per Format: Fo1	Areas 1.	
2	Health check-up as per Format: Fo2	Health check-up for Nos 1. New inductees 2. Drivers & Operators 3. Workers in following high risk areas: a. ...	
3	Induction training of newly joined workers as per Format: Fo3	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: Fo4	Locations of TBTs & No. of workers 1. ...	
5	PPE usage and issue as per Format: Fo6		
6	Inspection of T&Ps as per Format: Fo7	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: Fo8		
8	Inspection of Cranes & Winches as per Format: Fo9	List of Cranes & Winches & Nos. 1. ...	
9	Inspection of Height Working as per Format: F10	Areas: 1. ...	
10	Inspection of Welding & Gas Cutting operations as per Format: F11	Areas: 1. ...	
11	Inspection of Electrical Installations as per Format: F12	Locations: 1. ...	
12	Inspection of Elevators (as applicable) as per Format: F13	Locations: 1. ...	
13	Inspection of Excavation as per Format: F13E	Locations: 1. ...	



POWER SECTOR

Format for Monthly HSE Planning & Review

FORMAT NO: HSEP:14-F30

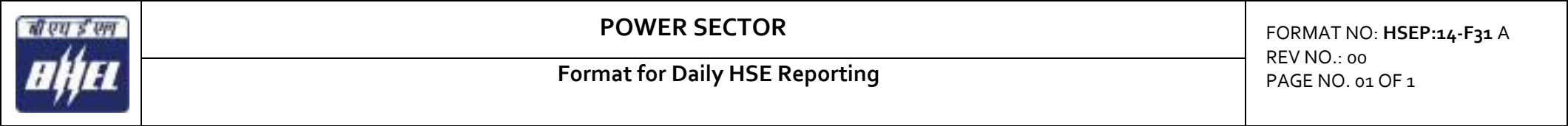
REV NO.: 00

PAGE NO. 02 OF 3

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
14	Job Safety Analysis as per Format F32B	Activities: 1. ...	
15	Regular Job Specific Training (Re-training) for workers involved in hazardous activities	Topics/ Hazards & No. of workers 1. ...	
16	Mass housekeeping (HK) drive in work areas	Areas 1. ...	
17	Vertigo Test of Height workers	Minimum No. of workers:	
18	Deployment of qualified HSE Officers as per contract	Location(s) & Nos. 1. ...	
19	Deployment of qualified HSE Stewards as per contract	Location(s) & Nos. 1. ...	
20	Deployment of Safety tools & Equipment (Safety Nets, Lifelines, Fall arrestors, Man-cages, flashback arrestors, scaffolding etc.)	Tool/ Equipment & Location 1. ...	
21	Safety Walks by site in charge of agency (4 -Weekly once)	Dates:	
22	Safety walks by departmental head (8-Weekly twice)	Dates:	
23	Availability/ deployment of Safety posters/ placards/ signage at strategic locations	Locations: Nos. 1. ...	
24	Provision of clean drinking water sources for workers	Locations: Nos. 1. ...	
25	Provision of toilets for workers (separate for male & female workers)	Locations: Nos. 1. ...	
26	Rest sheds for workers during lunchtime, rain, dust storm etc.	Locations: Nos. 1. ...	
27	Availability of following in Labor colony	1. Clean drinking water 2. Toilets 3. Cleanliness & Hygiene 4. Grass cutting, 5. Fogging 6. Electrical Inspection ...	

	POWER SECTOR		FORMAT NO: HSEP:14-F30 REV NO.: 00 PAGE NO. 03 OF 3
	Format for Monthly HSE Planning & Review		
SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
28	Availability of dust/ waste bins at various locations	Locations: 1. ...	
29	Availability of Ambulance (individual/ joint) in each shift	Ambulance No.	
30	Availability of emergency vehicle in each shift	Emergency vehicle	
31	Deployment/ Availability of tested Fire Extinguishers	Locations & Nos. 1. ...	
32	Tree plantation	Locations & Nos. 1. ...	
33	Waste disposal & Scrap Bins	Locations 1. ...	
34	Illumination checks	Locations 1. ...	
35	Safety award function: 1. Display of good practices Award presentation	Minimum 1 per month	
36	Submission of Daily Reports as per Format No.F31A	Daily Reports (Night & Day Shifts)	

PLAN		REVIEW	
<u>Agency</u> Name: Sign: Date:	<u>BHEL</u> Name: Sign: Date:	<u>Agency</u> Name: Sign: Date:	<u>BHEL</u> Name: Sign: Date:



	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

	POWER SECTOR	FORMAT NO: HSEP:14-F31 A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

Night		Day	SHIFT	Year	Site
			Submitted By		
			Work Area(s)		
			Staff		
			Man-Power		
			Safety Officers		
			Safety Stewards		
			Tool Box (Topics and No. of Participants)		
			Induction Training (No. of Participants)		
			Vertigo Test (Numbers Tested)		
			On-the-Job Training (Topic & participants)		
			Work Permits		
			Job Safety Analyses conducted		
			Height Work Inspection		
			Other Hazardous Activities Inspection		
NA			T&P Inspection (Names & Nos. Inspected)		
			Safety Walk (Designation, Areas)		
NA			HSE Meeting		
NA			Safety Reward (Details)		
NA			Housekeeping/ Dust Suppression/ Tree Plantation Activities (Locations/Details)		
			Lost time Accident		
			Restricted Work Case		
			Medical Treatment Case		
			First Aid Case		
			Near miss		
			Property Damage/ Fire		
			Non-Compliances Submitted by BHEL		
			Complied by Agency		
			Any other Remarks/ Inputs		



POWER SECTOR

Job Safety Analysis Format

FORMAT NO: HSEP:14-F32B

REV NO.: 00

PAGE NO. 01 OF 1

Name of the Site	
Name of the Subcontractor	
Activity, Area	

HAZARDS				PRECAUTIONS	

(Name)	Submitted By (Agency HSE)		Reviewed By (BHEL Execution)		Approved By (BHEL HSE)	
(Sign)						
(Date)						

**POWER SECTOR- HQ**

FORMAT NO: HSEP:14-F33

REV NO.: 00

PAGE NO. 01 OF 3

Checklist for Evaluation of HSE Performance

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
1a	Induction training for new workers conducted through audio-visual medium & documented ?	M	1	Induction Training Records
1b	Tool box talk conducted regularly as per plan, and documented?	M	1	Toolbox Talk Records
1c	Contractor in charge and safety in charge attended safety meetings?	M	2	Minutes of Meeting
1d	Whether observations in safety meetings are complied before next meeting?	M	2	-do-
1e	Preparation and submission of Monthly HSE report within stipulated time	M	1	Report submission date
1f	Preparation and submission of Incident/near-miss report and RCA Report (as applicable) within stipulated time	M	1	Incident/ Near Miss Records
1g	Carrying out Inspections and submission of Inspection reports within stipulated time	M	1	Inspection Records
1h	Regular Job Specific Training ensured for High Risk Workers (through audio-visual medium) as per plan	M	1	Training & Attendance Records
2a	Whether the contractor is registered under BOCW	M	2	BOCW Registration Certificate
2b	Availability of Qualified safety officer (1 for every 500 labour)	M	2	Safety Officer qualification & experience records
2c	Availability of Qualified safety supervisor (1 for every 100 labour)	M	2	Safety Officer qualification & experience records
2d	All the workers are provided and using safety helmets and safety shoes/gum boots	M	2	PPE Issue Records, Inspection/ non-conformity records
2e	Housekeeping done on regular basis and scrap removal at site	M	1	Housekeeping records, Inspection/ non-conformity records
2f	Usage of Goggles/Face shields and Hand gloves for gas cutter and grinders		1	PPE Issue Records, Inspection/ non-conformity records
2g	Wall openings & floor openings are guarded?		1	Inspection/ non-conformity records
2h	Adequate illumination provided in all working area?		1	Inspection/ non-conformity records
2i	Safety posters, sign boards and emergency contact numbers in all prominent location are displayed?		1	Inspection/ non-conformity records
2j	Availability of automatic reverse horns, Main horn, hook latches for Vehicles, mobile cranes, Hydras		1	Inspection/ non-conformity records
2k	Ban of carrying mobile phones to work place is implemented for workers		1	Inspection/ non-conformity records
2l	Availability of Tags & Inspection Certificates for Cranes of all capacities		1	Master T&P List with internal & external test details
2l.2	Availability of Tags & Inspection Certificates for Winches of all capacities		1	Master T&P List with internal & external test details
2l.3	Availability of Tags & Inspection Certificates, color coding for Chain pulley blocks		1	Master T&P List with internal & external test details
2l.4	Availability of Tags & Inspection Certificates for Vehicles - Trailers, Dozers, Dumpers, Excavators. Mixers etc.		1	Master T&P List with internal & external test details
2l.5	Availability of Tags & Inspection Certificates for Welding machines, grinders, Drilling machines, etc.		1	Master T&P List with internal & external test details
2l.6	Availability of Tags & Inspection Certificates, colour coding for Wire rope slings etc.		1	Master T&P List with internal & external test details
2l.7	Availability of Tags & Inspection Certificates for Batching plants		1	Master T&P List with internal & external test details

**POWER SECTOR- HQ**

FORMAT NO: HSEP:14-F33

REV NO.: 00

PAGE NO. 02 OF 3

Checklist for Evaluation of HSE Performance

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
2m.1	Use of Lifting Permit as per requirement		1	Permit Records
2m.2	Use of Height Permit as per requirement		1	Permit Records
2m.3	Use of Hot Work Permit as per requirement		1	Permit Records
2m.4	Use of Excavation permit as per requirement		1	Permit Records
2m.5	Use of Confined space work permit as per requirement		1	Permit Records
2m.6	Use of Grating removal and safety net removal permit as per requirement		1	Permit Records
2m.7	Use of Lockout-Tag out permit as per requirement		1	Permit Records
2m.8	Use of Radiography permit as per requirement		1	Permit Records
2m.9	Use of Night/ Holiday Work Permit as per requirement		1	Permit Records
2m.10	Use of Any other Applicable Permit as per requirement		1	Permit Records
3a	Material safety data sheet(MSDS) available for all chemicals and displayed in usage and storage area?		1	Inspection/ non-conformity records
3b	Spillages of oil/concrete and other chemical is controlled and cleaned by proper method in case of spill?		1	Inspection/ non-conformity records
3c	Availability of adequate number of urinals in workplace and in elevations and maintained	M	1	
3d	Availability of rest rooms for workers at site	M	1	
3e	Availability of Drinking water facility at work spot		1	
3f	Hygienic Labour colony is provided for workers.		1	
4a	Is heavy/complex critical lifting permit obtained for heavy, complex materials before handling/erection activity?		1	Work Permit records
4b	Whether area below lifting activities barricaded		1	Inspection/ non-conformity records
4c	Availability of experienced rigging foreman		1	Experience details of rigging foreman
4d	Is agency is following proper storage and handling procedure as per manufacturer standard for all hazardous material?		1	Procedure for storage & handling
4e	Are oxygen and acetylene cylinders are transported to work place from storage area in trolleys		1	
5a	Whether all deep excavation has been protected by barrier		1	Inspection/ non-conformity records
5b	Sloping/benching & shoring provided for excavation as per requirement?		1	-do-
5c	Proper access and egress provided for excavations?		1	-do-
5d	Blasting is done in controlled manner?		2	-do-
6a	Whether Electrical booth is equipped with Co ₂ fire extinguishers and fire buckets filled with sand?		2	Inspection/ non-conformity records
6b	Availability of Illumination lamp in electric booth?		1	-do-
6c	whether Caution Boards have been displayed?		1	-do-
6d	Usage of Metal Plug top for all hand power tools ?		1	-do-
6e	Usage of Insulated welding cables.		1	-do-
6f	Electrical Booth/Distribution Board to be covered by proper Canopy.		1	-do-
6g	Availability of functional & individual 30mA ELCB / RCCB and MCB for protection and conducting periodical check-up?		1	-do-
6h	Double earthing for panel boards and all machinery & proper earth pit with regular inspection available?		1	-do-
6i	Whether Electrician is qualified and experienced		1	Qualification & Experience records of electrician
6j	Availability and usage of Rubber hand gloves by electrician?		1	Inspection/ non-conformity records

	POWER SECTOR- HQ	FORMAT NO: HSEP:14-F33
	Checklist for Evaluation of HSE Performance	REV NO.: 00 PAGE NO. 03 OF 3

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
7a	Whether Scaffolding pipes made with steel or aluminum, are being used and checked periodically by experienced/ certified scaffolder?		2	Inspection/ non-conformity records
7b	8mm Stainless Steel wire rope with plastic cladding is provided for life line (Vertical / Horizontal) during height work?		2	-do-
7c	Availability of emergency lighting in case of power failure		1	-do-
7d	Whether all the openings are covered with Safety Nets made of fire proof Nylon?		1	-do-
7e	Whether MS pipe rails around staircases & platforms in usage are provided with top, middle rails and toe guard ?		1	-do-
7f	Whether Ladder with vertical life line /Fall arrestor is available to climb?		1	-do-
7g	Whether all workers deployed for working at height have been issued height pass after undergoing vertigo test?		1	Height Pass records
7h	Whether all workers deployed for height work / climbing ladder are provided and using Double lanyard safety belt?		1	PPE Issue records, inspection/ non-conformity reports
7i	Is all hand tools/Small material used by height workers is tied firmly to prevent fall?		1	-do-
8a	Flash back arrestors for all gas cutting sets is available on Torch side and cylinder side		1	Inspection/ non-conformity records
8b	Oxygen/Acetylene/LPG cylinders not in use have caps in place and stored separately?		1	-do-
8c	Availability of Face screen, Hand gloves, and Apron, for welders		1	-do-
8d	Protection from falling hot molten metal during metal cutting / welding at height by providing GI sheet below the cutting area especially in fire prone areas		1	-do-
9a	Pre-employment medical check-up done for all workers and submitted?		1	Medical check records
9b	Availability of first aid center, with MBBS doctor(Own or Sharing basis)	M	2	Attendance records
9c	Availability of Ambulance facility 24 hours (Own or sharing basis)	M	2	-do-
9d	Is First aid trained personnel's are available and their names are displayed at site?	M	1	-do-
9e	Availability of Emergency vehicle at site		1	
9f	Periodical medical check-up is conducted for all the workers and submitted?		1	Medical check records
9g	Availability of sufficient number of first aid box as per standard list and maintaining record		1	Inspection records
10a	Availability of Fire extinguishers, buckets at all vulnerable points		2	Fire extinguisher records
10b	Periodic fire mock drill conducted?		1	Fire, Mock drill records
10c	Are all flammable materials are stored separately?		1	
10d	Periodic grass cutting is done in material storage area?		1	
10e	Availability of 24V DC lighting in confined space work area		1	
10f	Availability of exhaust fan in confined space work area		1	

Note:

- **M: Mandatory; O: Optional.** Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL
- Additionally: 30 Marks for each Fatal Accident and 10 mark for each major accident shall be deducted.



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

BURNING/WELDING /HOT WORK PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____

Name of Work Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site

Second Copy – BHEL SAFETY

Third Copy : Contractor



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

LIFTING ACTIVITY PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____ Name of Work

Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Unwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorized/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked and in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site**Second Copy – BHEL SAFETY****Third Copy : Contractor**



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

WORKING AT HEIGHT PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____ Name of Work

Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site**Second Copy – BHEL SAFETY****Third Copy : Contractor**



**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	20100.00	19980.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	11320.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	55940.00
4	PORTAL CRANE, 360T	15	14070.00	13980.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	55110.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	68180.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	33300.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	20810.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	29970.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	31470.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	26220.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	36110.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	15030.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18850.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	16650.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	21640.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10820.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	13320.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10780.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10650.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8820.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9990.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9990.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5390.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	6110.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5340.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4390.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	3010.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2260.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2260.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	710.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	380.00
30	ELECTRIC GANTRY CRANE 3T	5	430.00	430.00
31	ELECTRIC GANTRY CRANE 5T	5	540.00	540.00
32	ELECTRIC GANTRY CRANE 30T	5	3640.00	3620.00
33	FORK LIFT 5T	5	650.00	650.00
34	FORK LIFT 3T	5	540.00	540.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	22340.00	22200.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12570.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	62160.00
4	PORTAL CRANE, 360T	15	15630.00	15540.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	61240.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	75760.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	37000.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	23120.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	33300.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	34960.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	29130.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	40120.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	16700.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20950.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	18500.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	24050.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	12020.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14800.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11970.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11840.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9800.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	11100.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	11100.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5980.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6790.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5940.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4880.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3350.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2510.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2510.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	790.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	430.00
30	ELECTRIC GANTRY CRANE 3T	5	480.00	480.00
31	ELECTRIC GANTRY CRANE 5T	5	600.00	600.00
32	ELECTRIC GANTRY CRANE 30T	5	4040.00	4030.00
33	FORK LIFT 5T	5	720.00	720.00
34	FORK LIFT 3T	5	600.00	600.00

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELCTRIC WINCH 5T	1270
6	ELCTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTRATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTRATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTRATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1360
6	OIL FILTRATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	1820
7	OIL FILTRATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m ³ /Hr)	1160
22	Air Blower (Flow: 20000 m ³ /Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGNOSTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. : FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. : FLOW 15 M3/HR	430
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELECTRIC WINCH 5T	1410
6	ELECTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m ³ /Hr)	1290
22	Air Blower (Flow: 20000 m ³ /Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGNOSTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast -	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH	510

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400