VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

CONTENTS

Sl.No.	DESCRIPTION	Chapter	No. of Pages
Vol IA	**Part-I: Contract specific details**		
1	Project Information	Chapter-I	02
2	Scope of works	Chapter-II	06
3	Facilities in Scope of Contractor / BHEL (Scope Matrix)	Chapter-III	11
4	T&Ps and MMEs to be deployed by Contractor	Chapter-IV	10
5	T&Ps and MMEs to be deployed by BHEL on sharing basis	Chapter-V	02
6	Time Schedule	Chapter-VI	06
7	Terms of Payment	Chapter-VII	03
8	Accounting of materials	Chapter-VIII	10
9	Progress of work	Chapter-IX	03
10	Bill of Quantity	Chapter-X	01
11	Material Handling	Chapter-XI	02
12	Taxes & Duties	Chapter-XII	03
13	General	Chapter-XIII	10
Vol IA	**Part-II: Technical specifications**		
1	Corrections / Revisions in General Conditions of Contract and Forms & Procedures.	Chapter-1	04
2	Technical Specifications	Chapter-2	674
3	Bore log details	Chapter-3	38
4	Plot Plan	Chapter-4	01
5	T&P Hire Charges	Chapter-5	12
6	"HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev01)	Chapter-6	82
7	Format for Form no.: F-14 (Rev 01); Monthly Plan and Review with Contractors	Chapter-7	06
8	Format for Form no.: F-15 (Rev 03); Monthly Performance Evaluation of contractor	Chapter-8	08
9	Proforma of Bank Guarantee (in lieu of Earnest Money)- Form WAM 23	Chapter-9	03
10	Proforma of Bank Guarantee (in lieu of Security Deposit)- Form WAM 22	Chapter-11	03
11	Procedure 2.3-Procedure for Conduct of Conciliation Proceedings	Chapter-10	11

VOLUME-IA PART – I CHAPTER – I

PROJECT INFORMATION

1.1 INTRODUCTION

Kothagudem TPS Unit-12 (1x800 MW) is set up by TELANGANA STATE GENERATION CORPORATION (TSGENCO) at a site in Paloncha Village near Kothagudem district, Telangana, India. 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.

1.2 PROJECT INFORMATION

S. no.	Description	Details
1	Name of the Project	KOTHAGUDEM THERMAL POWER STATION STAGE-VII, UNIT#12
2	Station Capacity	1X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (TSGENCO)
4	Site Location	The mentioned plant has been installed adjacent to the existing D colony of Kothagudem thermal power station at Kothagudem
5	Location Co ordinate	17.55 N 80.618 E
7	Nearest Town	Kothagudem
8	Nearest Railway Station	Bhadrachalam road (Known as Kothagudem)
9	Nearest Airport	180 Km (Vijayawada)
10	Site Conditions	

S. no.	Description	Details
a.	Ambient Air Temperature	
	Daily minimum (average)	13.5°C
	Daily maximum (average)	44.7°C
b.	Rainfall	
	Average annual	1100 mm
c.	Wind Data	
	Basic wind speed at 10m height	44 m/sec
	Wind pressure	As per IS: 875 Part III-1984
d.	Seismic Zone	Zone III as per IS: 1893-2002

VOLUME-IA PART – I CHAPTER – II

SCOPE OF WORKS

2.1. The scope of works covers Civil, structural and architectural works of the Flue gas desulphurization (FGD) area of Stage-VII, Unit 12 of 1x800 MW Kothagudem TPS as mentioned below, including supply of all materials (excluding Cement, Reinforcement steel, MS round for earthing & Structural steel), labour, tools and plants. The scope of work is indicative but not limited to the given below.

The indicative list of structures and buildings in the package is mentioned below.

AREAS OF WORK

1. FGD Control Room
2. Absorber foundation
3. Booster fans foundation
4. FGD Duct supporting foundation
5. RC Pump foundation
6. Oxidation Blowers foundation
7. Instrument Air Receiver foundation
8. Pipe rack – Slurry Piping & Cabling rack foundation
9. SO_2 Analyser room
10. Tanks foundation
    a. Process water Tank
    b. Auxiliary Absorbent Tank
    c. Foundation of Limestone slurry storage Tank
    d. Foundation of Waste water storage Tank
    e. Foundation of Secondary Hydro cyclone Feed Storage Tank
11. Absorber area drain and sump for tanks - 1no.
12. Slurry pumps foundation
    a. Auxiliary Absorbent pump– 1 no
    b. Gypsum Bleed pump– 2 no

13. Water pumps foundation
    a. Process water pumps– 2 no
    b. Process water boost up pumps– 2 no
    c. Mist eliminator & Emergency quench pumps– 2 no
14. Pumps foundations modifications
15. LT Transformer f/n in transformer yard
16. Bus duct structure f/ns
17. Basin for FRP cooling tower
18. ACW/ ECW pump house for FGD
19. MCC room for ACW PH
20. DG set foundation and paving
21. Roads & Drains
22. Pipe rack structure
23. Day Silo Support structure
24. Wet Ball Mill Building (WBM) & Wet Ball Mill Foundation
25. Gypsum De Watering Building (GDWB)
26. Limestone silo's Foundation
27. Pump Foundations
28. Crusher House
29. ERH - Emergency Reclaimer hopper for lime stone
30. CON-1A/B
31. Gypsum Shed
32. Gypsum Conveyor – related Civil works
33. Lime Stone Shed
34. Cable Rack
35. Miscellaneous Structures

Some of the systems/facilities shall come outside plant boundary/ premises. The same are to be executed by bidder at the quoted price and no extra payment over BOQ rates shall be payable. Proper care of existing roads & drains (related to the

work area covered under the scope of work) shall be taken in the course of execution of contract.

Note: The above provided list is indicative only for the bidder's guideline. **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 shall be provided by BHEL free of cost. If BHEL provides Structural Steel for embedments/inserts from scraps (if available), payment shall be made as per corresponding item in BOQ.

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, transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. 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.

2.3 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.

2.4 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.

2.5 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.

2.6 The unit rates for various items of BOQ shall include all the stipulations mentioned in technical specifications and nothing extra over BOQ rates shall be payable.

2.7 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.

2.8 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.

2.9 In case of any conflict between section –C and Section-D, Section C of specification prevails.

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:

2.11 All work places shall have adequate arrangements for temperature screening and provide sanitizers at convenient places.

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.

2.13 Use of AROGYA SETU will be encouraged for all employees both private and public.

2.14 Contractor shall sanitize their work place between shifts.

2.15 Large meetings to be prohibited. Spitting shall be strictly prohibited. Wearing of face cover is compulsory.

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.

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:
    a. Entrance gate of work place, office, if any
    b. Cafeteria and canteens, if any
    c. Meeting room, conference halls/ open area available/ verandah/ entrance gate of site, bunkers, porta cabins, buildings, etc.
    d. Equipments and lifts
    e. Washroom, toilet, sink, water points, etc.
    f. Wall/ all other surfaces
2. 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.
3. All vehicles and machinery entering the premise should be disinfected by spray mandatorily.
4. Mandatory thermal scanning of everyone entering and exiting the work place to be done.
5. Medical insurance for the workers to be made mandatory.
6. 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.

7. Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
8. 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.
9. Not more than 2/4 persons (depending on size) will be allowed to travel in lifts or hoists.
10. Use of staircase for climbing should be encourages.
11. There should be strict ban of gutka, tobacco, etc. and spitting should be strictly prohibited.
12. There should be total ban on non-essential visitors at sites.
13. 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.

VOLUME-IA PART – I CHAPTER – III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR/ BHEL

(SCOPE MATRIX)

S. No	Description – Part I	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.1	**PART I**			
3.1.1.0	**ESTABLISHMENT**			
3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		Free of charges as provided by TSGENCO
B	Open space for storage	Yes		Free of charges as provided by TSGENCO
C	Construction of bidder's office, canteen and storage building, cement storage shed including supply of materials and other services		Yes	
D	Bidder's all office equipment's, office/ store/ canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	

S. No	Description – Part I	Scope to be taken care by		Remarks
		BHEL	Bidder	
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	
3.1.1.2	**FOR LIVING PURPOSES OF THE BIDDER**			
A	Open space		Yes	
B	Living accommodation		Yes	
3.1.2.0	**ELECTRICITY**			
3.1.2.1	Electricity for construction purposes	Yes		Free of charges as provided by TSGENCO
3.1.2.1.1	Single point source	Yes		
3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
3.1.2.2	Electricity for the office, stores, canteen, labour hutments, etc. of the bidder which include:		Yes	
3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	

S. No	Description – Part I	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
3.1.2.2.4	Demobilization of the facilities after completion of works		Yes	
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	
3.1.3.0	**WATER SUPPLY**			
3.1.3.1	For construction purposes			
3.1.3.1.1	Making the water available at single point	Yes		Free of charges as provided by TSGENCO
3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	

S. No	Description – Part I	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.1.3.2	Water supply for bidder's office, stores, canteen, labour hutments, etc.		Yes	
3.1.3.2.1	Making the water available at single point		Yes	
3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
3.1.4.0	**LIGHTING**			
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	
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	
3.1.5.0	**COMMUNICATION FACILITIES FOR SITE OPERATIONS OF THE BIDDER**			
3.1.5.1	Telephone, Fax, internet, intranet, email etc.		Yes	

Sl.No	Description – Part II	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.2	**PART II**			
	CONSTRUCTION FACILITIES			
3.2.1.0	**Engineering works for construction**			
3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		Progressively
3.2.1.2	Detailing of drawings for construction		Yes	In consultation with BHEL
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	”
3.2.1.4	Shipping lists etc. for reference and planning the activities	Yes	Yes	”
3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL, As per requirement
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	

Sl.No	Description – Part II	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.2.1.7	Weekly construction schedules based on Sl No 3.2.1.5		Yes	of BHEL targets
3.2.1.8	Daily construction / work plan based on Sl No 3. 2.1.7		Yes	For daily monitoring meeting at site
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	
3.2.1.10	Preparation of preassembly bay		Yes	
3.2.1.11	Laying of racks for gantry crane if provided by BHEL or brought by the contractor / bidder himself			**Not applicable**

3.3 **OPEN SPACE:**

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 Civil /mechanical/ electrical contractors and the storage of plant machineries and materials. The existing land shall be shared by all erections 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, temporary site office, storage area, storage shed (s) etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

Land for labour colony shall be provided by BHEL within 2 km from site. The contractor to construct labour colony/ hutment as per statutory requirements (as applicable) after obtaining approval of formalities from statutory body. The contractor shall provide adequate water arrangement for drinking/ washing/ bathing with required toilets, drainage system, and electrification etc. in labour colony at his own cost. Suitable paved area to be provided in the labour colony at contractor's own cost.

3.4 **ELECTRICITY:**

3.4.1 Construction power will be provided to the contractor free of cost at one single point within the plant area by BHEL as provided by TSGENCO. The contractor to Provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc.

3.4.2 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.

3.4.3 Any duty, deposit involved in getting the Electricity shall be borne by the bidder. As regards contractor's office shed also all such expenditure shall be borne by the contractor.

3.4.4 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, 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.

3.4.5 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.

3.4.6 Contractor has to make their own arrangements for electricity requirement for labour colony at his own cost.

3.4.7 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.

3.5 **WATER:**

3.5.1 Water (Raw water) required for construction purposes will be provided at one single point within the plant area free of cost as provided by TSGENCO. The required pumps & accessories, pipes for drawing water from the given point and further distribution will be arranged by the contractor at their cost to go on without interruptions.

3.5.2 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. Contractor has to make his own arrangements for his water requirement for his labour colony at his cost.

3.6 **MATERIAL SUPPLY:**

Supply/ providing aggregate, sand and all other materials required for the work are in the scope of the contractor. **BHEL shall provide cement and reinforcement steel for civil works, MS round for earthing, structural steel for fabrication works only for incorporation in the permanent work AS FREE SUPPLY**.

- Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum 100 MT each per 60 Cum batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the number of cement silos shall be increased based on the site requirement. 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 shall be minimum two months. Provision of necessary storage arrangement for cement received in bags is in the scope of successful bidder within the quoted price.

- 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.

- Bidder to note that steel materials required for embedments, inserts, MS grating, galvanized grating, stainless steel stop lock gates, sluice gates, stainless steel stationery screens, fasteners like MS/ HT/ HSFG bolts/ nuts, lock nuts, washers and foundation bolts other than those supplied by BHEL, shall be supplied by the bidder.

3.7 **CONSUMABLE**

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.

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.

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.

3.10 **BLASTING**

Bidder should produce documentary evidence of valid blasting license for Telangana State (or) should produce documents for having tie-up with agency who is possessing valid blasting license for Telangana state within 30 days from issue of LOI.

For details on blasting, refer enclosed bill of quantity (rate schedule) & Volume-IA Part-II, Technical specification.

3.11 **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.

3.12 BID DRAWINGS

Plot plan drawing enclosed is only tentative and for information purpose and this may get revised during execution.

VOLUME-IA PART – I CHAPTER – IV

T&PS TO BE DEPLOYED BY CONTRACTOR

4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.

4.2 The contractor is required to arrange the following tentative Major T&Ps and other T&Ps for the satisfactory completion of the work.

Sr No	T&P items	Mobilizing time from the date of start of work
I	**Major T&P items**	
A1	2 No. Poclain CK90 excavator	1 no. within 20 days, balance as per BHEL requirement at site
A2	2 No. JCB	1 nos. within 20 days and balance in a progressive manner as per BHEL requirement at site
A3	05 nos. dumper/Tipper	2 nos. Within 20 days. And balance in a progressive manner as per BHEL requirement at site.
A4	1 no. Portable automatic concrete batching plant (Output 60 cum/ hr) with printing facility and independent DG Backup. With 2 Nos of minimum 100 MT cement silo for each batching plant	1 no. to be commissioned Within 45 days or as mutually agreed between bidder and engineer In-Charge of BHEL.
A5	5 nos. transit mixer (5/6 M3 capacity) including 1 nos standby.	3 nos within 45 days and balance within in a progressive manner as per BHEL requirement at site.
A6	2 no. Truck mounted concrete mixer cum pump along with placing boom minimum 36 m high (i.e. concrete boom placer)	1 No Within 30 days. and balance as per BHEL requirement at site.
A7	1 nos. concrete pump (60 cum/ hr min capacity & lift 90M)	As mutually agreed between bidder and engineer In-Charge of BHEL

Sr No	T&P items	Mobilizing time from the date of start of work
		Note: With prior approval of Engineer In-Charge at site, concrete pump can be replaced by another concrete boom placer.
II	Other T&Ps	
A8	1 nos. Concrete cutting power tools (DD2E of HILTI/BOSCH make)	As per BHEL requirement at site
A9	1 no. Concrete coring machine for drilling in concrete up to 150mm dia along with diamond bits	As per BHEL requirement at site
A10	4 nos. Jack Hammer	As per BHEL requirement at site
A11	3 nos. self-priming dewatering pump 5 HP (diesel)	As per BHEL requirement at site
A12	3 nos. self-priming dewatering pump 5 HP (electric)	As per BHEL requirement at site
A13	1 no. 20 HP submersible mono-block electric pump (KOS-1040+ of Kirloskar or equivalent),	As per BHEL requirement at site
A14	4 nos. self-priming dewatering pump 2 HP (1 each diesel/ electric)	As per BHEL requirement at site
A15	4 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	As per BHEL requirement at site
A16	1 no. dozer. D 50	As per BHEL requirement at site
A17	5 nos. reinforcement bending machine	3 nos. within 20 days and balance as per BHEL requirement at site
A18	4 nos. reinforcement cutting machine	2 nos. within 20 days and balance as per BHEL requirement at site.
A19	Adequate quantity of scaffolding pipe / ACROW PIPE for both inside & outside the boundary works	As per BHEL requirement at site

Sr No	T&P items	Mobilizing time from the date of start of work
A20	1 no. Vibromax (earth compactor)	As per BHEL requirement at site
A21	1 no. compression testing machine (200 T cap)	1 no. within 50 days.
A22	Civil laboratory equipment's as per list IN Sl 4.4 with temporary building 1. one AC lab size 4.5mtrx6mtr 2. one non AC lab 4.5 mtrx4.5 mtr.	Within 55 days.
A23	1 nos. total station with adequate arrangement for Surveyors.	1 no. Within 15 days,
A24	3 nos. auto level & staff	2 nos. Within 15 days, balance as per BHEL requirement at site.
A25	120 nos. concrete cube moulds (150 X 150 X 150mm)	Within 15 days.
A26	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/ shuttering etc. within site	As per BHEL requirement at site
A27	1 nos. drinking water tank – 5000 lit.	1 nos. Within 30 days.
A28	1 no truck mounted water tank capacity with sprinkler arrangement.	Within 30 days.
A29	1 nos. mobile toilet blocks for labour use.	1 nos. within 30 days balance
A30	1 nos. truck mounted 125 KVA DG set	1 no. within 30 days
A31	Construction power cable	As per BHEL requirement at site
A32	Construction water Pipeline	As per BHEL requirement at site
A33	10 nos. Concrete vibrator with adequate needle (Minimum 5 nos. diesel driven)	4 Nos (at least 2 nos. diesel driven) within 45 Days. Balance as per BHEL requirement at site.

Sr No	T&P items	Mobilizing time from the date of start of work
A34	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.	25% within 30 days and balance progressively within 90 days.
	STRUCTURAL WORKS	
I	**Major T&P items**	
B1	1 nos 75MT/ 100MT capacity crawler cranes for erections	As per BHEL requirement at site
B2	3 nos. pick & carry crane minimum 10MT capacity	1 nos. – Within 60 days. Balance progressively as per BHEL requirement at site
II	**Other T&Ps**	
B3	1 Nos. Radial drill machine	As per BHEL requirement at site
B4	1 nos. magnetic base drill machine	As per BHEL requirement at site
B5	2 nos. submerged arch welding machine	As per BHEL requirement at site
B6	2 nos. MIG machine	As per BHEL requirement at site
B7	30 Nos Welding rectifier	As per BHEL requirement at site
B8	1 no. trailor – 15T	As per BHEL requirement at site
B8	1 no. power driven HSFG bolt tightening m/c	As per BHEL requirement at site
B10	1 no. torque tightening m/c. (Capacity up to 30mm dia HSFG bolt tightening)	As per BHEL requirement at site
B11	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 requirement at site
B12	Power winch – 3T	As per BHEL requirement at site
B13	Power winch – 5T	As per BHEL requirement at site
B14	1 no ultra-sonography testing machine with recording device for structural work.	As per BHEL requirement at site

Sr No	T&P items	Mobilizing time from the date of start of work
B15	1 nos. Painting equipment sets complete with required compressor, hopper, screen, blasting hose pipe, nozzle airless/ conventional spray (within CGI temporary cover shed)	As per BHEL requirement at site
B16	Chain block (3MT/5MT/10MT)	As per BHEL requirement at site
B17	Ropes/slings including D-shackles	As per BHEL requirement at site
B18	Grinding & Buffing machines	As per BHEL requirement at site
B19	Steel jolly for temporary working platforms	As per BHEL requirement at site

Note:

1. T&P shown in the above mentioned list and the mobilization schedule is tentative requirement considering parallel working in all areas. However, mobilization schedule modification as well as no. of T&Ps as mutually agreed at site for major 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 work within schedule/ target date of completion without any additional financial implication to BHEL. Vendor shall 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. 6.1. of this specification (i.e. TCC) may please be referred for date of start of work.
6. Mobilization of concrete boom placer in place of concrete pump will be allowed based on site requirement of BHEL.

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

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.

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 carried out in compliance with the standards.

4.6 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment's like as given in table below:

SL 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 Angles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value 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
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383

SL NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
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

SL NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
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

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.

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.

4.9 In general, any crane (up to 150 MT) 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.

4.10 The age of the contractor deployed cranes up to 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.

4.11 In case the contractor fails to provide any T&P which is in the scope of contractor and if BHEL provides such T&P available with BHEL, hire charges prevailing (as per BHEL norms) as on that day will be recovered from the contractor as per the prevailing BHEL Corporate Crane hire charges (may vary from time to time). Corresponding pages of Corporate Crane hire charges are enclosed in Volume I Part II of Technical Conditions of Contract. This may get revised further as per the BHEL corporate guidelines. However, prevailing rates as on date of execution may be applicable.

4.12 Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.

4.13 In case, cement is issued through bulkers being supplied from manufacturer /stockiest, the same shall be emptied in cement silos of batching plant and necessary assistance shall be provided by contractor without any additional financial implication to BHEL. Contractor to note that batching plant being established at site shall have cement silos of 100 MT capacities (minimum 2 nos.) as mentioned in clause 4.2.- list of Tools & Plants to be deployed by the contractor.

VOLUME-IA PART – I CHAPTER – V

T&PS PROVIDED BY BHEL

5.1 BHEL will provide suitable higher capacity cranes above 150 MT capacity to the contractors as per the requirement at the discretion of BHEL on free of hire charges on shareable basis. The cranes of 150 MT and below is in the scope of bidder. Before requesting BHEL for higher capacity crane, agency has to ensure that all cranes of their scope upto 150MT and below should be available at site.

5.2 Besides the T & P mentioned above, which is being made available to the contractor on free of hire charges, any additional crane and other T & P which may be required for successful and timely execution of the work covered within the scope of this tender shall be arranged and provided at site by the contractor at his cost. In case if the contractor fails to provide such equipment's, BHEL will arrange for the same and the cost will be recovered from the contractor's bill with BHEL overheads, as applicable from time to time which may vary even during contract period.

5.3 BHEL's Crane is only for erection purpose and shall not be available for material handling or transportation purpose. Contractor shall make their own arrangements for material transportation to erection site.

5.4 BHEL may provide either BHEL owned cranes or hired cranes at the discretion of BHEL. Operator for the BHEL supplied cranes will be provided by BHEL on free of charges.

5.5 Bidder to note the following

5.5.1 <u>In the event of providing BHEL Cranes:</u>

5.5.1.a Fuel has to be arranged by the contractor at his cost.

5.5.2 <u>In the event of providing hired cranes:</u>

5.5.2.a Fuel has to be arranged by the contractor at his cost.

5.6 For all BHEL's crane, BHEL shall provide crane operators free of charges, all consumables for BHEL crane maintenance shall be provided by the contractor within the quoted rates.

5.7 Tentative List of consumables required to be provided by contractor is as below:

5.7.1 Engine Oil 15 W 40

5.7.2 Fuel Filters

5.7.3 Air Filters

5.7.4 Hydraulic Filters

5.7.5 Hydraulic Oil –Servo 68

5.7.6 Gear Oil- Servo 90

5.7.7 Engine oil Filter

5.7.8 Oil Separator Filter

5.7.9 Rope-CRG 100 Grease

5.7.10 Grease- Servo Multi-Purpose Grease

Maintenance for the BHEL crane shall be carried out by BHEL. Bidder shall extend support (if required) for routine maintenance works.

VOLUME-IA PART – I CHAPTER-VI

TIME SCHEDULE

6.1. **TIME SCHEDULE**

6.1.1 The date of commencement of work at site shall be mutually agreed date between bidder and BHEL.

6.1.2 The entire work of Civil, Structural and Architectural works as detailed in the Tender Specification shall be completed within **13 (Thirteen) months** from the date of commencement of work with intermediate milestones as mentioned in Clause no. 6.7.

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.

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.

6.2. **MOBILISATION**

The Contractor has to subsequently augment his resources in such a manner to achieve the COMPLETION SCHEDULES:

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 in to consideration of the COMPLETION SCHEDULES /site decision on drawings flow (latest) and submitted for BHEL's approval.

6.3. 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.

6.4. 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.

6.5. SUBMISSION OF L3 SCHEDULE

The contractor shall submit and a detailed area/structure wise L3 schedule within 15 days in consultation with BHEL based on the tentative schedule provided as per the clause 6.7. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects 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. 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.

6.6. GUARANTEE PERIOD

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

6.7. CIVIL WORKS SCHEDULE FOR FGD OF KOTHAGUDEM THERMAL POWER STATION, STAGE-VII, UNIT#12

6.7.1 SCHEDULE OF WORK

The schedule for civil works is as given below.

S. No.	Description	Completion month from the contractual date of start of the work
1.	Absorber system foundation	Progressively by 4th month
2.	FGD flue gas ducting foundation	Progressively by 4th month
3.	Booster Fans foundation	Progressively by 4th month
4.	Tank foundations	Progressively by 5th month
5.	Lime stone storage silo foundation	Progressively by 5th month
6.	Gypsum dewatering building	Progressively by 6th month

S. No.	Description	Completion month from the contractual date of start of the work
7.	RC pump foundation + Oxidation blower house	Progressively by 7th month
8.	Pipe rack – Slurry piping & cabling rack	Progressively by 7th month
9.	DG sets foundation	Progressively by 7th month
10.	All interconnecting pipe sleepers	Progressively by 7th month
11.	Ball mill building (Lime stone grinding house)	Progressively by 8th month
12.	Pump foundations	Progressively by 8th month
13.	Air receiver foundations	Progressively by 8th month
14.	Drain sumps	Progressively by 8th month
15.	Transformers foundations	Progressively by 9th month
16.	FGD MCC control room	Progressively by 10th month
17.	SO2 Analyser room	Progressively by 12th month
18.	Material reconciliation and final bill submission	Progressively by 13th month

6.7.2 **INTERMEDIATE MILESTONES**

Intermediate milestones are as below.

S No	Description	Completion month from the contractual date of start of the work	Intermediate Milestone
1	Absorber system foundation	4th Month	M1
2	Ball mill building (BMB) (Lime stone grinding house)	8th month	M2

6.7.2.1 M1 and M2 shall be intermediate milestones for this work. Incase delay in achieving M1 milestone the penalty shall be levied on the bidder. Incase 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. Incase 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.

6.7.2.2 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.

6.7.2.3 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.

6.7.2.4 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.

6.7.2.5 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.

6.7.2.6 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.

6.8. **COMPLETION SCHEDULE**

6.8.1 The above schedule is tentative.

6.8.2 The above completion schedule against each structure/ building is for entire completion and handing over the structure/ Building to BHEL. The foundations, pedestals, floors, and any structure, required for the start of structural erection work/ civil work/ mechanical equipment erection work, shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

6.8.3 In case the activities in the schedule are to be advanced, the related civil/ structural activities in the scope of the contractor are to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

6.9. 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 bidder taking in to consideration of the COMPLETION SCHEDULES / site decision on drawings flow (latest) and submitted for BHEL's approval.

6.10. In order to meet the 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 Engineer.

6.11. The bidder must submit a detail schedule (area wise) for completion of work to meet civil work schedule given in clause 6.7 within 15 days from the date of issue of LOI.

6.12. The major activities as mentioned against the work schedule given in clause No.6.7 are to be indicated in detailed schedule which will be prepared by the bidder.

6.13. **RECORDS TO BE MAINTAINED AT SITE**

6.13.1 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.

6.13.2 The under mentioned records/ log-books/ registers applicable to be maintained.

1. Hindrance register
2. Site order book
3. Test check of measurements
4. Cement supply and consumption daily register
5. Records of test reports of field tests
6. Records of manufacturer's test certificates

7. Records of disposal of scraps generated during and after the work completion.

VOLUME-IA PART – I CHAPTER-VII

TERMS OF PAYMENT

7.1 SECURED ADVANCE

Not applicable

7.2 ADVANCE FOR MOBILIZATION

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.

7.2.2 2% of contract value after receipt of initial Security Deposit and additional security deposit, as applicable if any, Security Deposit for consortium, if applicable, as per relevant clauses in the GCC/ TCC along with unqualified acceptance of detailed letter of intent.

7.2.3 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below and on certification by site in-charge for compliance provided clause no. 7.2.2 as mentioned above is also complied with.

1. JCB – 1 Nos.
2. Poclain CK90 excavator – 1 No
3. Batching Plant – 60 cum/hr. capacity – 1 No. with 2 Nos of silo (100MT each)
4. Transit mixers – 2 Nos.

7.2.4 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. JCB – 1 Nos.
2. Pick & carry Crane (minimum 10MT capacity) - 2 nos.

3. Concrete boom placer – 1 No.
4. Transit mixers – 2 Nos.
5. Civil Laboratory – 1 No.

7.2.5 Payment of the advance as specified herein and recovery of the advance will be as per clause 2.13 of GCC. Option of availing the interest bearing mobilization advance is left with the bidder.

7.3 INTERIM PAYMENT

7.3.1 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.

7.3.2 95% item rate shall be released after completion of works certification by Engineer in charge.

7.3.3 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.

7.3.4 Retention amount as mentioned in GCC shall be applicable.

7.3.5 BHEL Site Engineer, at discretion, may operate the part rate of the items where supply and installation are involved, on receipt of the materials at site.

7.4 ROYALTY/ SEIGNIORAGE CHARGES

Royalty/ seigniorage charges for excavation, as applicable as per Govt. of Telangana for earth work shall be payable by the bidder at bidder's cost and proof of payment, i.e., challan of deposit of royalty fee shall be submitted to BHEL along with RA bill. The above royalty charges shall be inclusive within the quoted rate. No extra payment shall be applicable to the bidder.

In the absence of production of challan, the prevailing rate for royalty/ seigniorage fee shall be considered and the amount so calculated for the executed quantity shall be

withheld from the RA bill/ Final bill. On production of challan, payment of withheld amount for the quantity for which challan has been submitted, will be released.

7.5 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.

7.6 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.

VOLUME 1A PART-1 CHAPTER VIII

ACCOUNTING OF MATERIALS

8.1 ACCOUNTING OF MATERIALS ISSUED

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

8.2 ISSUE OF CEMENT

8.2.1 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 (Adequate numbers of cement silo of cumulative capacity of 200MT per 60CUM batching plant or as required for batching plant mobilized other than the capacity mentioned) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the No of cement silos shall be increased based on the site requirement. Cement unloading arrangements to silo and required manpower support shall be provided by the successful bidder at his own cost.

8.2.2 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. Proper storage area/ shed shall be constructed by successful bidder at his own cost.

8.2.3 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.

8.2.4 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

8.2.5 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 in 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.

8.2.6 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.

8.2.7 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/TSGENCO. 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.

8.2.8 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

8.2.9 **RETURN OF CEMENT**

Sealed cement bags remaining unused and in perfectly good condition at the time of completion or termination of the contract shall be returned promptly, (within 15 days from assessment) if BHEL/ Engineer is satisfied of the physical condition of the cement. Return of such cement to the project stores/ place as identified within the project area by Engineer/ BHEL will not be entitled to handling and incidental charges. Surplus sealed and good conditioned cement bags will be taken back on weighment basis.

8.2.10 **CEMENT CONSUMPTION**

The theoretical consumption of cement shall be based on the following.

i. For design mix concrete as per approved design mix.

ii. For nominal mix concrete work, as per minimum cement as specified or as approved by Engineer-in-charge.

For item of works, where volume mix is permitted in writing by the BHEL, for masonry works, plaster other miscellaneous items, the cement consumption shall be governed by the "Statement of Cement Consumption" attached to the Delhi schedule of Rates of CPWD-DSR- LATEST REVISION unless otherwise specified in the specifications or the drawing of contract or mutually agreed by Engineer-in-charge and contractor.

Actual consumption = Issue – Surplus/ unused quantity of cement returned in good condition by contractor to store. (No sweep cement will be taken back by BHEL).

8.2.11 **CEMENT WASTAGE**

Allowable wastage: One and half percent (+1.5%) of theoretical consumption of cement unless specified otherwise in the technical specification.

For any material issued by BHEL to the contractor free of cost, and which is not accounted by the contractor to BHEL, then recovery for such material shall be effected at penal rates.

Sl No	Cement consumption	Basis of issue & penal recovery
C-1	Theoretical consumption (without considering any wastage or loss).	Free
C-2	Actual consumption being Limited to one and half percent (+1.5%) of aforesaid theoretical consumption towards allowable wastage.	Free
C-3	Actual consumption beyond one and half percent (+1.5%) of above (C-1).	Penal rate

8.3 **ISSUE OF STEEL**

8.3.1 The steel shall be issued to the contractor on the following basis:

(a) Structural Steel : Weighment basis (Unit – MT)

(b) Reinforcement Steel and Earthing rod (MS round) Weighment basis (Unit – MT)

8.3.2 All the steel (structural, reinforcement, earthing MS rod,) issued by the BHEL shall be properly accounted for. The total quantity of steel required for the work will be calculated from the approved Bar Bending schedule, fabrication drawings, approved laps, chairs and lugs. The measurement for payment as well as for accounting shall be based on the sectional weights as indicated in the following IS specifications. No rolling tolerances shall be accepted in any case for issue, return, reconciliation & payment purpose.

IS: 808-1964	Beams, Channels and Angles
IS: 1730-1961	Plates, Sheets and Strips/Flats
IS: 1732-1971	Rounds including deformed high yield strength bars.

8.3.3 In case any such sectional weights are not available in the above documents, the manufacturer recommendation shall be binding.

8.3.4 The steel issued to the contractor shall be mainly in standard length and sections as received from the supplier. However, the contractor shall be bound to accept the steel in length as available in the project stores no claims for extra payment because of issue of non-standard length will be entertained.

8.3.5 The contractor shall satisfy himself of the quality and quantity of the materials at the time of taking delivery from BHEL stores. No claims whatsoever will be entertained by BHEL because of quality or quantity after the materials are taken by the contractor from BHEL stores.

8.3.6 The contractor shall submit to the engineer, a statement indicating estimated quantity of steel required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of steel during a month by the third week of the previous month indicating his requirement.

8.3.7 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.	Reinforcement Steel & Earthing rod MS round	Requirement of one month
2.	Structural Steel	Requirement of one month

8.3.8 Bidders to ensure that no lamination materials are taken over by them from BHEL.

8.3.9 Fabrication wastage, if any due to above, shall not be compensated by BHEL.

8.3.10 Bidder to note that steel materials required for MS Grating, Galvanised Grating, GI Handrail, Stainless Steel Handrail, Stop Lock Gate, Stationery Screen, 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.

8.3.11 **RETURN OF MATERIALS**

All surplus steel and all wastage materials will be taken back on weighment basis.

Surplus, unused and untampered steel shall be sorted section-wise and returned separately for a place directed by BHEL/Engineer within the project area. Return of such materials will not be entitled to any handling and incidental charges.

All wastage / scrap (including melting scrap, wastage, un usable scrap) shall be promptly returned to the stores and a receipt obtained for material accounting purposes. Return of such material will not be entitled to any transportation and incidental charge.

8.3.12 **SCRAP & SERVICEABLE MATERIALS**

1. All Structural steel of length above 2 M except M.S. Plate shall be considered as serviceable materials provided the materials is in good and acceptable condition. Structural steel in length less than 2 M shall be treated as scrap.
2. Plates having both sides greater than 1 Metre OR if any side is less than 1 M but greater than 0.5 M and the total area is equal or greater than 2 Sq. Metre shall be considered as serviceable.
3. All pipes measuring 2 M and above in length shall be treated as serviceable materials provided they are in good and acceptable condition. Pipe in less than 2 M length shall be treated as scrap.
4. All TMT measuring 3 M and above in length shall be treated as serviceable materials provided they are in good and acceptable condition. TMT in less than 3 M length shall be treated as scrap.

8.3.13 **STEEL CONSUMPTION AND WASTAGE**

8.3.13.1 **REINFORCEMENT AND EARTHING ROD MS ROUND STEEL CONSUMPTION AND WASTAGE**

a) CONSUMPTION

The theoretical consumption of various sections and/or diameter of reinforcement and earthing rod steel shall be based on approved construction drawing and bar bending schedule. Weight shall be calculated considering the sectional weights as per Indian standards. No extra cost shall be payable to the contractor for any deviation in weights for the different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

i. Actual consumption = Issue – Surplus.
ii. Surplus = Un-tampered, unused, uncut quantity of steel and Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 8.3.12 above)" returned by the contractor to BHEL store along with relevant documents
iii. Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

ALLOWABLE WASTAGE: - (+3%) of the theoretical consumption shall be considered as allowable wastage. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 3 % allowable wastage.

Sl .no	Consumption of Reinforcement steel & Earthing rod, MS round	Basis of issue
R-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
R-2	Wastage limited to plus three percent (+3%) of the aforesaid theoretical consumption (R-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
R-3	Wastage beyond three percent (3%) of the aforesaid theoretical consumption (R-1)	Penal rate

8.3.13.2 **STRUCTURAL STEEL, (ROLLED SECTION, PLATES ETC.) CONSUMPTION & WASTAGE**

a) CONSUMPTION

The theoretical consumption of various sections shall be based on approved drawings. Weights shall be calculated considering the sectional weights as per Indian standard. No extra shall payable to the contractor for any deviation in weights for the two different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

i. Actual consumption = Issue – Surplus.
ii. Surplus = Un-tampered & unused quantity of steel and Serviceable materials as stipulated under clause “Scrap and Serviceable Materials (Refer Clause 8.2.12. above)” returned by the contractor to BHEL store along with relevant documents.
iii. Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

Allowable wastage: - 4% (FOUR percent) of the theoretical consumption shall be considered. Wastage shall be considered as cut pieces and scrap material,

measured as per actual weighment basis. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 4 % allowable wastage.

Sl.no	Consumption of structural steel (rolled section, plates)	Basis of issue
S-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
S-2	Wastage limited to plus Four percent (+4%) of the aforesaid theoreticalconsumption (S-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
S-3	Wastage beyond four Percent (4%) of the aforesaid theoretical consumption (S-1)	Penal Rate

8.3.14 **RECONCILIATION OF MATERIALS**

The contractor shall submit a reconciliation statement of steel issued to him with each RA Bill.

At the time of submission of bills, the contractor shall properly account for the material issued to him as specified herein to the satisfaction of BHEL certifying that the balance materials are available with contractor's custody at site.

At the time of submission of bills by the contractor, if it is noticed by BHEL that the wastage is high and calls recovery at the penal rate, then, BHEL will proceed for recovery for the excess wastage as per penal recovery rates as specified.

The reference drawings for actual material consumption to be used for the purpose of reconciliation shall be drawings prepared by the BHEL and drawings approved by BHEL for fabrication works and such other drawings approved by BHEL. This shall also include the bar bending schedule prepared by the contractor and approve by BHEL.

8.4 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

8.5 PENAL RATE OF MATERIALS

S. no.	Description	Penal Rate
A	**REINFORCEMENT STEEL** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	**Rs. 63,000/-- per MT** plus GST or other taxes & duties
B	**STRUCTURAL STEEL – Long Products** Rolled steel Beams, channels, and angles, etc. in sizes and lengths as available.	**Rs. 69,347/- per MT** plus GST 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. 81,428/- per MT** plus GST or other taxes & duties
D	**CEMENT (OPC)**	**Rs. 3,770 per MT** plus GST or other taxes & duties

VOLUME-IA PART – I CHAPTER - IX

PROGRESS OF WORK

The scope of progress and monitoring of work will comprise of following but not limited to the following:

9.1 Refer forms F -14 to F-18 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

9.2 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.

9.3 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.

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

9.5 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.

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

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

9.8 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.

9.9 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.

9.10 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 -X

BILL OF QUANTITY

10.1 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.

10.2 The above mentioned "Total amount" is for the entire Bill of Quantity (BOQ) given in Part-C of the Price bid.

10.3 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.

10.4 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.

10.5 Based on the quantities of individual item and the amount arrived in S No.10.4 above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.

10.6 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 S No.10.5 above

10.7 The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The derived item rates (as mentioned above) for individual items shall remain firm irrespective of any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limit of Minus (-) 30% of awarded contract value. No compensation becomes payable in case the variation of the final executed contract value is in plus side.

VOLUME-IA PART –I CHAPTER -XI

MATERIAL HANDLING

11.1 Open land as provided by TSGENCO shall be provided by BHEL on free of cost basis. 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 provided within plant premises (inside plant boundary) and contractor shall make use of the area for installation 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 risk.

11.2 The system for receipt, storage & issue of materials shall be available with vendors for easy traceability.

11.3 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.

11.4 The contractor shall construct waterproof cement store (capacity 400MT) 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 arrangement.

11.5 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.

11.6 Clotting of cement and excessive rusting of steel must be avoided. In case, due to any cause attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of steel shall be recovered from the interim payment at the penal rate specified in the tender.

11.7 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of once in every month computerized reconciliation statement of such account to the BHEL along with RA bill.

11.8 All TMT shall be stacked over sleeper's diameter wise.

11.9 All structural steel shall be stacked plate size wise and thickness wise beams, channels and angles shall be stacked separately on sleepers.

11.10 Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

VOLUME-IA PART – I CHAPTER-XII

TAXES AND DUTIES

1.12.1 Goods and Service Tax (GST) & Cess

1.12.1.1 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.

1.12.1.2 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.

1.12.1.3 Bidder shall note that the GST Tax Invoice complying with GST Invoice Rules wherein the 'Bill To' details will be as below:

BHEL GSTN : 36AAACB4146P1ZG

NAME : BHARAT HEAVY ELECTRICALS LIMITED

ADDRESS : KOTHAGUDEM THERMAL POWER STATION STAGE-VII,

UNIT#12, PALONCHA KOTHAGUDEM, TELANGANA
BHEL PSSR SITE OFFICE

1.12.1.4 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.

1.12.1.5 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.

1.12.1.6 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.

1.12.1.7 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.

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

1.12.1.9 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.

1.12.1.10 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.

1.12.2 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.

1.12.3 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.

1.12.4 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.

1.12.5 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-XIII GENERAL

The scope of the work will comprise of but not limited to the following:

(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.13

1.13.1 Contractors are requested to furnish the following documents at PSSR-HQ, Chennai immediately after release of Letter of Intent (LOI).

i) Security Deposit and additional Security Deposit.
ii) Unqualified Acceptance for Detailed LOI / Work Order.
iii) Rs.100/- Stamp Paper for preparation of Contract Agreement.

1.13.2 Contractors are requested to furnish the proof of documents for the following at PSSR- Site

i) Provident Fund Registration Number.
ii) Labour License Number.
iii) Workmen Insurance Policy Number.

1.13.3 **In addition to the clause 2.8 of General Conditions of Contract (Volume-1C of Book-II) the contractor shall comply with the following.**

1.13.3.1 **BOCW Act & BOCW Welfare Cess Act**

1.13.3.1.1 The Contractor should Register their Establishment under BOCW Act 1996 read with rules 1998 by submitting Form I (Application for Registration of Establishment) and Form IV (Notice Of Commencement / Completion of Building Other Construction Work) to the respective Labour Authorities i.e.,

a) Assistant Labour Commissioner (Central) in respect of the project premises which is under the purview of Central Govt.–NTPC, NTPL etc.
b) Appropriate State authorities in respect of the project premises which is under the purview of State Govt.

1.13.3.1.2 The Contractor should comply with the provisions of BOCW Welfare Cess Act 1996 in respect of the work awarded to them by BHEL.

1.13.3.1.3 The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers, safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.

1.13.3.1.4 The contractor irrespective of their nature of work and manpower (Civil,

Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

1.13.3.1.5 Contractor shall make remittance of the BOCW cess as per the Act **in consultation with BHEL** as per the rates in force (presently 1%). BHEL shall reimburse the same upon production of documentary evidence. However, BHEL shall not reimburse the fee paid towards the registration of establishment, fees paid towards registration of Beneficiaries and contribution of Beneficiaries remitted.

1.13.3.1.6 Non-compliance to Provisions of the BOCW Act & BOCW Welfare Cess Act is not acceptable. In case of any non-compliance, BHEL reserves the right to withhold any sum as it deems fit. Only upon total compliance to the BOCW Act and also discharge of total payment of Cess under the BOCW Cess Act by the Contractor, BHEL shall consider refund of the Amounts

1.13.3.2 **PROVIDENT FUND**

1.13.3.2.1 The contractor is required to extent the benefit of Provident Fund to the labour employed by you in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, you are hereby required to get yourself registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to you by the Provident Fund authorities within one month from the date of issue of this letter of intent. In case you are exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of your failure to comply with the provisions of said Act, if recoveries therefore are enforced from payments due to us by the customer or paid to statutory authorities by us, such amount will be recovered from payments due to you.

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

1.13.3.3 **OTHER STATUTORY REQUIREMENTS**

1.13.3.3.1 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.

1.13.3.3.2 The contactor 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.

1.13.3.3.3 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 contactor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.13.3.3.4 The Contractor shall submit copies of Final Settlement statement of disbursal of retrenchment benefits on retrenchment of each workmen 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.

1.13.3.3.5 In case of any dispute pending before the appropriate authority under ID 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.

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

1.13.3.4 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.

1.13.3.5 **RECOVERY OF COMPENSATION PAID TO VICTIMS BY BHEL IN CASES OF DEATH/ PERMANENT INCAPACITATION OF PERSON DUE TO AN ACCIDENT DURING THE WORKS**

BHEL shall recover the amount of compensation paid to victim(s) by BHEL towards loss of life / permanent disability due to an accident which is attributable to the negligence of contractor, agency or firm or any of its employees as detailed below.

a) **Victim:** Any person who suffers permanent disablement or dies in an accident as defined below.

b) **Accident:** Any death or permanent disability resulting solely and directly from any unintended and unforeseen injurious occurrence caused during the manufacturing / operation and works incidental thereto at BHEL factories/ offices and precincts thereof, project execution, erection and commissioning, services, repairs and maintenance, trouble shooting, serving, overhaul, renovation and retrofitting, trial operation, performance guarantee testing undertaken by the company or during any works /during working at BHEL Units/ Offices/ townships and premises/ Project Sites.

c) **Compensation in respect of each of the victims:**
In the event of death or permanent disability resulting from Loss of both limbs: Rs. 10,00,000/- (Rs. Ten Lakh)
In the event of other permanent disability: Rs. 7,00,000/- (Rs. Seven Lakh)

d) **Permanent Disablement**: A disablement that is classified as a permanent total disablement under the proviso to Section 2 (I) of the Employee's Compensation Act, 1923."

1.13.4 **GENERAL**

1.13.4.1 **Site Visit by the Bidder**

The bidder shall, prior to submitting his tender for the work, visit, examine and acquire full knowledge & information and necessary conditions prevailing at the site and its surroundings of the plant premises together with all statutory, obligatory, mandatory requirements of various authorities about the site of works at his own expense, and obtain and ascertain for himself on his own responsibility that may be for preparing his tender and entering into a contract, and take the same into account in the quoted contract price for the work.

1.13.4.2 The bidder shall satisfy themselves about the following factors:

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.

1.13.4.3 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.

1.13.4.4 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.

1.13.4.5 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 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.

1.13.4.6 The work covered under this specification is of highly sophisticated nature, requiring the best quality workmanship, engineering and construction management. The contractor must have adequate quantity of tools, construction aids, equipments etc., in his possession. He must also have on his rolls adequate trained, qualified and experienced supervisory staff and skilled personnel.

1.13.4.7 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.

1.13.4.8 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.

1.13.4.9 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.

1.13.4.10 The contractor shall carry out additional tests, if any, which the Engineer feels necessary because of site conditions and also to meet system specification.

1.13.4.11 The work shall be executed under the usual conditions without affecting power plant construction / operation 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 others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.13.4.12 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.

1.13.4.13 Wherever Construction sequences are furnished by BHEL, the contractor shall follow the same sequence. 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.

1.13.4.14 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.

1.13.4.15 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.

1.13.4.16 Contractor shall retain all T&P / Testing instrument / Material handling equipment's 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.

1.13.4.17 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 Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.

1.13.4.18 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.

1.13.4.19 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.

1.13.4.20 The contractor must obtain the signature and permission of the security personnel of the customer / BHEL 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. Surplus materials including steel item brought at site by the contractors with proper documentation and Gate pass, shall be allowed to taken out of the project premises after completion of relevant works, on certification by BHEL in charge.

1.13.4.21 Contractor shall remove all scrap materials periodically generated from his working area and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. 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.

1.13.4.22 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.

1.13.4.23 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.

1.13.4.24 No member of the already erected structure / buildings, other component and auxiliaries should be removed / modified without specific approval of BHEL engineer.

1.13.4.25 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on latest ISO 9001 Standards.

1.13.4.26 Sometimes, it may be required to re-schedule the activities to enable other agencies to commence/ continue the work so as to keep the overall project schedule.

1.13.4.27 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.

1.13.4.28 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.

1.13.4.29 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.

1.13.4.30 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.

1.13.4.31 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.

1.13.4.32 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.

1.13.4.33 The contractor will be responsible for the safe custody and proper accounting of all materials in connection with the work. If the contractor has drawn materials in excess of design requirements, recoveries will be effected for such excess drawls at the rate prescribed by manufacturing units.

1.13.4.34 Contractor has to clear the front, expeditiously and promptly as instructed by BHEL Engineer for other agencies, like Boiler, piping, Turbine, Generator erection, Cabling, instrumentation, insulation etc., to commence their work from / on the equipments coming under this scope.

1.13.4.35 For the purpose of planning, contractor shall furnish the estimated requirement of power (month wise) for execution of work in terms of maximum KW demand.

1.13.4.36 RECORDS TO BE MAINTAINED AT SITE:

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.

The under mentioned Records/ Log-books/ Registers applicable to be maintained.

(i) Hindrance Register
(ii) Site Order Book.
(iii) Test Check of measurements.
(iv) Cement Supply and Consumption Daily Register
(v) Records of Test reports of Field tests.
(vi) Records of manufacture's test certificates.
(vii) Records of disposal of scraps generated during and after the work completion.
(viii) List of T&Ps and MMEs

1.13.4.37 SITE INSPECTION

1.13.4.37.1 The Owner 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 or his authorized agents without any extra cost to the Owner or his authorized agents. No cost whatsoever such duplication of inspection of work be entertained.

1.13.4.37.2 BHEL / Owner 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 Owner / BHEL.

1.13.4.37.3 The contractor shall maintain at site a joint protocol for recording actual measurement of work carried out at site, inspection and witnessing of various tests conducted by the contractor.

1.13.4.37.4 Field Quality Assurance (FQA) Formats:-

It is the responsibility of the contractor to collect and fill up the relevant FQA log sheets of BHEL and present the same to BHEL after carrying out the necessary checks as per the log sheets and obtaining the signature of BHEL and Owner as token of their acceptance. Payment to the contractor will be inked with the submission of these FQA log sheets.

1.13.4.37.5 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.

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

VOLUME-IA PART-II CHAPTER-1

CORRECTIONS / REVISIONS IN SPECIAL CONDITIONS OF CONTRACT, GENERAL CONDITIONS OF CONTRACT AND FORMS & PROCEDURES

Sl No.: 1

Clause 4.1.11 of SCC is deleted.

Clause 4.2.2.9 alone is revised as below.
In construction projects of this magnitude it is possible that all the areas/ approaches may not be ready. In such cases backfilling of approaches where ever necessary, 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.

Sl No.: 2

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 Rev 01) enclosed.

Chapter IX Clause 9.1.1 to 9.1.25 stands deleted.

Chapter IX Clause 9.2 to 9.62 stands deleted.

Sl No.: 3

Clause No. 10.5 on RA Bill Payments, in Special Conditions of Contract (SCC), Volume- IB, Book- II, is revised as under:

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.

Sl No.: 4

EARNEST MONEY DEPOSIT

Proforma of Bank Guarantee (in lieu of Earnest Money)- Form WAM 23 is enclosed with this Tender.

Sl No. 5

The following clause is added under clause 1.10 Security Deposit in General Conditions of Contract (Volume I Book II):

1.10.8 Bidder agrees to submit security deposit required for execution of the contract within the time period mentioned. In case of delay in submission of security deposit, enhanced security deposit which would include interest (Base rate of SBI + 6%) for the delayed period, shall be submitted by the bidder. Further, if security deposit is not submitted till such time the first bill becomes due, the amount of security deposit due shall be recovered as per terms defined in NIT / contract, from the bills along with due interest

Sl No.: 6

In addition to clause 2.7.9 of General Conditions of Contract (GCC), a New clause 2.7.9.1 is added as below.

2.7.9.1 Penalty for Intermediate Milestones

2.7.9.1.1 M1 and M2 shall be intermediate Milestones for this work.

2.7.9.1.2 In case of slippage of these identified Intermediate Milestones, Delay Analysis shall be carried out on achievement of each of these two Intermediate Milestones in reference to Form 14.

2.7.9.1.3 Incase delay in achieving 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.

2.7.9.1.4 Incase delay in achieving M2 milestone is solely attributable to the contractor,0.5% per week of executable contract value* limited to maximum 3% of executable contract value will be withheld.

2.7.9.1.5 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.

2.7.9.1.6 Amount required to be withheld on account of slippage of identified intermediate milestone(s) shall be withheld out of respective milestone payment and balance amount (if any) shall be withheld @10% of RA Bill amount from subsequent RA bills.

2.7.9.1.7 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. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.

2.7.9.1.8 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 in to 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.

Sl No.: 7

PRICE VARIATION COMPENSATION (PVC)

Clause 2.17.5 under The PRICE VARIATION COMPENSATION (PVC) clause 2.17 published in General Conditions of Contract (Volume IC Book-II) is revised as under.

"Base date shall be calendar month of the scheduled completion date (i.e. actual start date + scheduled contractual completion period as per letter of intent/ award and/or work order)".

Sl. No.: 8

Procedure 2.3 that forms the part of Forms and Procedures is published as *Chapter 10 in Volume IA Part II* of this booklet (Volume-I Book-I).

Sl No.: 9

The chapter Reverse auction procedure published in 'Forms and Procedures' of Volume I Book-II stands deleted. 'Guidelines for Reverse Auction-2021' available in the website http://www.bhel.com -> Supplier Registration, shall be applicable**.**

Sl No.: 10

Existing format for BANK GUARANTEE FOR SECURITY DEPOSIT, as available in Form No. F-11 (Rev 00) of Volume ID Forms and procedures stands deleted. Refer Proforma of Bank Guarantee (in lieu of Security Deposit)-Form WAM 22 provided in *Chapter- 09, Part-II of Volume-IA* Technical Conditions of Contract.

Sl No.: 11

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-14 of Volume ID Forms and procedure stands Deleted. Form No.- F-14 (Rev 01) is enclosed.

Sl No.: 12

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-15 of Volume ID Forms and procedure stands Deleted. Form No.- F-15 (Rev 03) is enclosed.

Sl No.: 13

Existing format for Integrity Pact, as available in Volume ID Forms and procedure stands Deleted. Refer revised format for Integrity Pact provided in *Annexure – 7* of Notice Inviting Tender (NIT).

Sl. No.: 14

Clause 2.14.1 in GCC regarding Quantity Variation in General Conditions of Contract (GCC), Volume-1C, Book- II is revised as under:

"The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The derived item rates (as mentioned above) for individual items shall remain firm irrespective of any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limit of Minus (-) 30% of awarded contract value. No compensation becomes payable in case the variation of the final executed contract value is in plus side."

VOLUME-IA PART – II

Next Chapters are as below

Chapter 2	Technical Specifications	674
Chapter 3	Bore log details	38
Chapter 4	Plot Plan	01
Chapter 5	T&P Hire Charges	12
Chapter 6	"HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev01)	82
Chapter 7	Format for Form no.: F-14 (Rev 01); Monthly Plan and Review with Contractors	06
Chapter 8	Format for Form no.: F-15 (Rev 03); Monthly Performance Evaluation of contractor	08
Chapter 9	Proforma of Bank Guarantee (in lieu of Earnest Money)- Form WAM 23	03
Chapter 10	Proforma of Bank Guarantee (in lieu of Security Deposit)- Form WAM 22	03
Chapter 10	Procedure 2.3-Procedure for Conduct of Conciliation Proceedings	11

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
[TSGENCO]

KOTHAGUDEM THERMAL POWER STATION
STAGE-VII, UNIT#12, [1 x 800 MW]

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-410-600-C001

SECTION - B
PROJECT INFORMATION

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

INTRODUCTION

Kothegudem (1X800 MW) is being set up by Telengana State Power Generation Corporation Limited (TSGENCO) at Kothegudem. The site is located within the premises of existing Kothagudem Thermal Power Station which already accommodates 4x60+4x120+2x250+1x500 =1720 MW units. One 800 MW supercritical unit will be installed for augmentation of total plant capacity.

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.

APPROACH TO SITE

The site is about 3.3 KM from Palvoncha city.
Nearest Railway station-- Bhadrachalam Road (BDCR)
Nearest Airport – Vijaywada
Nearest Seaport – Vizag

1.	Owner	Telengana State Power Generation Corporation Limited(TSGENCO)
2.	Owner Consultant	DCPL
3.	Project Title	Kothagudem Thermal power Station Stage-VII-Unit-12 (1X800 MW TPS)
4.	Location	3.3 KM from Palvoncha city.
5.	Location Co ordinate	17.55 N, 80.618 E
6.	Nearest Railway Stn.	Bhadrachalam Road (BDCR)
7.	Ambient Air Temperature	
	a. Maximum	44.7 Deg.C
	b. Minimum	13.5 Deg.C

8. Rainfall
    a. Average annual 1100 mm
9. Wind Data
    a. Basic wind speed at 10m height
    44 m/sec
    b. Wind pressure As per IS: 875 Part III-1984
10. Seismic Zone Zone III as per IS: 1893-2002

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
[TSGENCO]

KOTHAGUDEM THERMAL POWER STATION
STAGE-VII, UNIT#12, [1 x 800 MW]

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-410-600-C001

SECTION - C
SPECIFIC TECHNICAL REQUIREMENTS

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

VOLUME : VII-A

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

CONTENTS

VOLUME : VII-A **GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS**

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GENERAL	VII-A : 1
2.00.00	SCOPE OF CIVIL AND STRUCTURAL WORK	VII-A : 2
3.00.00	CODES AND STANDARDS	VII-A : 14
4.00.00	UNITS AND LANGUAGE	VII-A : 26
5.00.00	GENERAL SITE INFORMATION	VII-A : 26
6.00.00	SITE DEVELOPMENT AND UTILITIES	VII-A : 27
7.00.00	GEO-TECHNICAL CRITERIA	VII-A : 36
8.00.00	LOAD AND STABILITY CONSIDERATION	VII-A : 37
9.00.00	BUILDING DESIGN CONCEPT	VII-A : 51
10.00.00	DESIGN OF REINFORCED CONCRETE STRUCTURES	VII-A : 52
11.00.00	DESIGN OF STEEL STRUCTURES	VII-A : 71
12.00.00	STRUCTURAL MATERIALS	VII-A : 79
13.00.00	GENERAL DESCRIPTION	VII-A : 83
14.00.00	DESCRIPTION OF MAJOR PLANT STRUCTURES/ COMPONENTS	VII-A : 88
15.00.00	MISCELLANEOUS REQUIREMENT	VII-A : 128
16.00.00	STATUTORY REQUIREMENT	VII-A : 132

CONTENTS [Contd…]

VOLUME : VII-A **GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS [Contd…]**

CLAUSE NO.	DESCRIPTION	PAGE NO.
17.00.00	DOCUMENTS TO BE SUBMITTED	VII-A : 133
18.00.00	LAYOUT	VII-A : 136
19.00.00	WORKMANSHIP	VII-A : 136
20.00.00	TEMPORARY WORK	VII-A : 137
21.00.00	INTERFACE WITH STRUCTURES UNDER OTHER SCOPE OR EXISTING STRUCTURES	VII-A : 137
22.00.00	SEQUENCE OF WORK AND PROGRESS REPORT	VII-A : 137
	ATTACHMENT	
ANNEXURE-1	GROUND CONTOUR PLAN	VII-A : 137
ANNEXURE-2	FINAL FEASIBILITY STUDY REPORT BY RITES LIMITED	VII-A : 138

VOLUME : VII-A

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

1.00.00 GENERAL

This specification is intended to cover general as well as technical specification required for design, supply, execution & erection of complete Civil, Structural and miscellaneous work required for completion of 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner.

The work shall include design, construction and erection activities of both underground and above ground civil and structural work and shall include all working drawing, labor, materials, plants, equipment, transportation and all incidental items not shown or specified explicitly but reasonably implied and necessary for proper completion of the project, all in strict compliance with this specification, including the revision and amendments thereto as may be required during the execution of the work.

The work shall be carried out according to the design/drawing to be developed by the Contractor and approved by the Owner/Owner's Consultant. For all building, structure, foundations, roads, drainage, necessary details and layout shall be prepared by the Contractor keeping in view the functional requirement of the plant and the facilities and providing enough space and access for operation use and maintenance. The drawings and specifications attached herewith do not provide complete description of each and every system but state the minimum functional requirement for the plant as a whole or certain individual components.

All the quality of work and standards pertaining to field and laboratory testing, excavation, concreting, fabrication, erection, welding and other technical requirements shall strictly conform to the Technical Specification for Civil, Structural and Architectural Work - Volume VII-C of this Bid Document. The specifications are intended for the general description of the work, quality and workmanship. The specifications are not, however, intended to cover the minutest details and the work shall be executed according to the spirit of the specification and in the absence thereof according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the local public work department practice or to the recommendation of relevant American & British Standards or to the instruction of the Owner. The IS Codes to be followed are mentioned in the relevant Technical specification for different items of work. All civil and structural work shall conform to approved Architectural drawing wherever applicable and General Specification and Design Criteria for Architectural Work - Volume VII-B of this bid document.

The bidder is expected to get clarified any doubts about the specification etc., before bidding through discussion with the Owner recorded in writing in respect of interpretation of any portion of this documents. The Owner reserves the right to alter/amend any part/criteria of this specification in the interest of the project without creating any financial implication whatsoever on the part of Owner.

Before bidding the contractor shall visit the site to get fully acquainted with site condition, approaches, transport facilities, off-site facilities, availability of materials, storage space, fabrication and bar bending yard, accommodation of workmen, site office, testing laboratory and other assorted facilities. The bidder or its consultants, if any, shall have well-equipped design office with modern drafting, validated civil/structural analysis and design soft-wares, computing and transmission facilities to comply with high rate of drawing/document production pertaining to civil & structural system to meet the stipulated time frame laid down in the specification. No extra claim shall be entertained for any unforeseen reason.

The contractor's offer shall cover the complete requirements as per the best prevailing practices and to complete satisfaction of owner.

2.00.00 SCOPE OF CIVIL AND STRUCTURAL WORK

The scope of civil and structural work comprises all necessary investigations, survey, foundations, buildings, substructures, superstructures and infrastructure required for the effective functioning of various systems of the power plant whether or not they are specifically mentioned.

The scope of work includes all the following work in conformity with approved Mechanical / Electrical layout drawings but not limited to the following.

A. Site preparation

In general, demolition of existing quarters, leveling and grading of the site will be taken up by TSGENCO. Any additional site preparation work required in detail engineering stage will be in bidder's scope.

- Detail Soil investigation including measurement of soil resistivity.
- Excavation, dewatering, shoring and strutting, backfilling ,disposal of surplus soil outside of plant boundary as per requirement
- Dewatering /slope protection work if required

B. **Power Block area**

- Power house building including Control room, Crane girder, Turbo Generator foundation and other equipment foundations. Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladders at two ends.

- Boiler area foundations including Boiler, ESP, Fan foundations, Duct supporting columns and other foundations (Equipment and structural steel work for boiler and auxiliaries will be covered under mechanical sections)

- Boiler area paving with drainage

- Mill Building including coal bunkers and mill foundations

- Mill reject loading hoppers

- ESP Control Room

- Chimney

C. **Transformer yard**

- Transformer yard foundations and substructure including Transformer foundations, Bus duct supporting structures and foundations, foundations for pylon and deluge valves for transformer fire detection and protection system, Rail track, fire wall, common oil pits, electrical trenches, pull pits and duct banks, drainage, gates, fencing, paving etc. all complete.

- RCC roads within switchyard, fire protection walls and chain link fencing for switchyard. RCC paving shall be provided in Transformer Yard.

- All other buildings structures and foundations as per approved electrical layout

D. **Switchyard**

- Switchyard structures, foundations, drains, pits, switchyard roads, RCC cable trench, gate, fencing, paving in yard using fly ash bricks in panels with pointing wherever required etc all complete.

For prevention of vegetation, the graded ground shall be covered with fly ash bricks pavement over 300 mm ash filling to be provided in the switchyard area. Each fly ash layer shall be compacted/consolidated by using ½ ton roller with 4 to 5 passes and suitable water sprinkling. The method of application of chemicals used for soil sterilization /anti-wed treatment shall be as per manufacturer's recommendation. Also, the RCC pathway shall be provided in switchyard as per the requirement. An approved system for draining the transformer oil collection and disposal system shall be provided.

- Switchyard control room
- All other buildings structures and foundations as per approved electrical layout

E. **Coal Handling system**

Separate marshalling yard of 6 lines and one additional line requirement from Gajulagudem to plant about 3 km will be provided to cater to the requirement of proposed unit as per RITE's report attached with the specification as annexure-2. EPC contractor to carry out any new or modification work in such a way that the existing structure and foundations are not disturbed and coal linkage to existing units can be continued un-interrupted.

- Wagon Tippler (2nos)
- Track Hopper
- Conveyor galleries with supporting trestles, and foundations
- In motion weigh bridge
- RCC tunnel
- Transfer points
- Pent house
- Crusher house
- Stacker/Re-claimer foundations
- Reclaim Hopper
- Crushed Coal stock pile yard for a storage of 30 days
- 1,00,000 MT Coal storage shed
- Control room / MCC room for coal handling plant

- Tanks / Reservoirs, Sumps, Pump Houses, Compressor House for Dust suppression and other utilities and fire fighting system
- All other buildings, structures and foundations as per approved mechanical layout

F. **Ash Handling system**

- Ash Slurry sump and pump house
- Bottom Ash overflow sump
- Ash water sump and pump house
- Coarse ash tank and pump house
- Fly ash equipment tower
- Ash blower/compressor building
- Vacuum pump House
- Ash handling plant switchgear cum control room
- Pipe rack for conveying the ash and water pipes
- Ash pipe corridor including providing proper drainage arrangements within the plant area.
- Fly Ash Storage Silo (2 nos.) with concrete approach road
- Silo utility building
- HCSD Pump shed
- Mill reject silo
- Foundations for clarifier and other equipments as per system requirement

- Ash pond by construction of earthen bund in extent of Ac.230.00 of land under acquisition including the construction of respective spillway, decantation well and RCC vent for relieving the water from ash pond in to the natural drain.

- Ash water recovery pump house.

- Civil foundations for 100 MT capacity weigh bridge for weighing the ash trucks as per site requirement during detailed engineering.

- All other buildings, structures and foundations as per approved mechanical layout

G. **Fuel oil System**

The HFO/LDO required for the proposed Unit will be pumped from Fuel Oil system to the day tanks.

EPC contractor to carry out any modification work for enhancement of capacities of existing system such that the existing structure and foundations are not disturbed.

- HFO/LDO Day Tank foundations and dykes with RCC pavement.

- HFO/LDO pipe supporting pedestals.

- HFO/LDO Forwarding Pump House

- HFO/LDO Pressurising Pump House

- All other buildings, structures and foundations as per approved mechanical layout.

H. **Raw water supply and pretreatment system including Intake**

- Re-routing of existing GRP pipe line passing through the new plant area using MS pipe line of 1200 mm dia.

- Raw Water Reservoir

- Raw Water Pump House

  EPC Contractor to carry out any modification work for enhancement of capacities of existing system such that the existing structure and foundations are not disturbed and water linkage to existing units can be continued un-interrupted.

- Clarified water storage tank
- Clarified water pump house
- Aerator
- Stilling Chamber
- Distribution Chambers
- Solid Contact Clarifier with approach stair cases to be provided diagonally at two sides of clarifiers.
- Rapid gravity filter
- Filtered water Reservoir and Pump House
- Sludge Sump & Pump House
- Filter Backwash Waste Sump & Pump House
- Chemical House cum RWPT Chlorination Building
- All other buildings, structures and foundations as per approved mechanical layout.

I. **Demineralised & Potable water supply system**

- DM Plant Building
- DM-Neutralizing pit and Pump House
- Potable water tank with the necessary pipe lines to all the buildings.
- All other buildings, structures , tanks and foundations as per approved mechanical layout

J. **Condensate Polishing System**

- CPU – Regeneration Building
- CPU- Neutralizing pit and Pump House
- All other buildings, structures , tanks and foundations as per approved mechanical layout

K. **CW system**

- Natural Draft cooling tower
- Cooling water pipes and return pipes upto inlet flange of cooling tower including their supports and foundations, thrust blocks etc. wherever required
- CW pump house and fore bay alongwith a walkway with handrails across the forebay adjacent to CW pumphouse, channel from NDCT to CW pump house
- Provision of gates to facilitate dewatering and cleaning of sump.
- CW Treatment Plant cum Chlorination Building
- All other buildings, structures and foundations as per approved mechanical layout

L. **Fire fighting system**

- Fire water tanks
- Fire water pump house
- Foundations for Pylon and deluge valves
- Deluge Valve canopy with RCC slab.
- All other buildings, structures and foundations as per approved mechanical layout.

M. **Waste Water Treatment System**

- Boiler Blow Down Drain Pit and P/H
- Backwash Waste Water from SSF Collection Pit and P/H
- Central Monitoring basin
- CMB Effluent Transfer P/H
- Flocculation Tank, Inclined Surface Settler
- Inclined Surface Settler Sludge Pit and P/H
- Coal Particle Settling Basin

- Coal Decanted Water Sump and P/H
- Sludge Thickener
- Centrifuge Building
- Chemical House for WWTS
- Retention Pit for Transformer Yard Oily Waste Pit and P/H
- Retention Pit for TG Building Area Oily Waste and P/H
- Retention Pit for Fuel Oil Storage Area Oily Waste and P/H
- Pre Oil Water Separator Retention Pit and P/H
- Retention Pit for Treated Effluent from OWS and P/H
- CPI Sludge Pit and P/H
- All other buildings, structures and foundations as per approved mechanical layout.

N. **Centralized Sewage Treatment System**

- Fixed Bar Screen Chamber
- Sewage Equalization Sump and P/H
- Extended Aeration Tank
- Settling Tank
- Clear Water Storage Tank
- Clear Water Transfer P/H
- Treated Water Storage Tank and P/H
- EPC Contractor will finalise required number and strategic locations of individual sewage lifting stations during detail engineering, subject to approval of the owner / owner's consultant.
- Finalising the location and size of centralized STP subject to approval of the owner / owner's consultant will also be in the scope of contractor.

- All civil and structural work associated with Sanitary sewer disposal system including inspection pits, manholes etc. for all buildings and facilities, providing sewerage pumps & pump houses, the pipelines connecting the individual sewage lifting stations with the central STP as per approved lay-out , will be within the scope of this contract.

O. **Other Utility services and Non-plant Building**

- Pipe and Cable racks
- Mill Reject handling compressor room and silo
- DG Building
- Air Washer Building and Compressor House
- Bulldozer shed and auto repair shop
- Ware house and chemical / hazardous stores
- AC Plant room
- VFD Building (if applicable)
- CPU Regeneration building
- Water Harvesting Well
- Guard pond
- Overhead storage water tank for potable water and service water
- Parking Sheds
- Service building including workshop
- Stores complex
- Chemical Lab room cum office with office furniture
- Maintenance Tool Room
- Dress change rooms and Locker rooms for workmen.
- Storage yard including storage sheds
- Canteen building

- Weigh Bridge Control Rooms
- Township
- Security gate and Watch towers in plant and Township
- Potable water system which shall be constructed in the plant at water treatment plant and pipe line shall be laid from PTP system up to 10 m beyond plant boundary as per the route shown during detailed engineering for supply of potable water to colony. Necessary pipeline network shall be provided in the plant by the bidder for supply of potable water in the plant to different locations.

P. **Plant roads and drainage**

- All internal roads, culverts & pavement within the battery limit of this specification.
- Some of the requirement for main roads is indicated on Plot Plan. However, additional roads and access to individual buildings/structures/facilities which are not specifically shown in layout but where access is necessary from inspection, operation & maintenance point of view, they shall be required with suitable designed pavement with RCC and shall be provided by the EPC Contractor.
- The scope shall also include modification and diversion of existing roads, where necessary. Approach road to ash dump area will be in EPC Contractor's scope of work.
- Complete storm water drainage system ~~for Stage-2 areas~~ with garland drains around building/structure/facilities, including providing drainage pumps (if required) along with pump house; storm water drains along both sides of the road, etc. The proposed drainage system with RCC in the plant area shall be suitably designed to discharge the effluents of the plant & storm water and to be connected to existing drains of KTPS-V & VI Stages. The scope shall also include modification and diversion of existing drains, where necessary.

Q. **Miscellaneous scope of work**

- Excavation for foundations and substructures, wherever necessary in all types of soil including shoring, dewatering, filling around foundations and to grade with compaction of fills and approaches.
- Extension of Raw Water Pump House near Godavari river at Burgampahad with additional Raw Water Pump .

- Construction of RCC room for installation of electrical panels for providing construction power supply.

- Laying of water supply lines for providing construction water from given point of source.

- Dismantling of existing structures/roads/culverts. Fouling structures are to be modified /re-laid/re-constructed/dismantled are in the scope of EPC Contractor only.

- Boundary walls, Chain link/barbed wire fencing & gates wherever required around any buildings/area. Any modification to the existing plant boundary wall to make it suitable for the requirement of proposed plant shall be carried out by the EPC contractor.

- Main plant paving including plinth protections around buildings and structures

- All foundations, grouting, embedment, inserts, bolts, etc. required for Ventilation, Dust Extraction, Water supply & Dust Suppression including drainage for the same.

- Civil and Structural work associated with all HVAC equipment and accessories as specified elsewhere in this specification including making of openings in floors / walls / roofs and building insulation as required.

- Civil and structural work associated with complete station lighting including area lighting, yard lighting, road (street) lighting, security lighting, etc. in all the areas.

- Providing High mast lighting in construction areas for illumination of construction works.

- Civil and structural work associated with Plant potable water supply, Potable water over-head tank of adequate capacity, associated pipe support trestles, pedestals & trenches within & outside buildings, all other civil work associated with service water system, etc.

- Slope protection for embankment including required filling work in plinth and plant area and RCC retaining wall along with pile wherever required.

- The scope shall also include all necessary civil work (mainly civil foundation) pertaining to erection of Generator Stator / Transformer including construction of Stator lifting portal foundations or any other equipment if required.

- Arrangement for unloading platform for TG Stator.

- Laying of required railway track necessary for shifting of Transformers/equipment /machinery.
- Construction of RCC pit and pedestals for Boiler Lift.
- Providing rails for electrical panels in HT Switchgear Room.
- All roofs shall be provided with access through M S staircase.
- Minimum 1.2m wide access path with tiles shall be provided on roofs.
- All roofs shall be provided with water proofing treatment.
- The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the civil work for the project.
- The land will be given to the Contractor by the Owner. All site investigations, surveys, grading, leveling and dressing and other additional work shall be carried out by the Contractor as per the approved drawing.
- During detail engineering the outfall structure for plant drainage shall be proposed by EPC contractor at a suitable location based on invert levels of existing plant drainage system as well as available contour drawings. The work shall be carried out based drawings to be developed by the Contractor and approved by the Owner.
- The work shall be carried out according to the design / drawings to be developed by the Contractor and approved by the Owner / Owner's authorised Consultant. For all building, structures, foundations, etc., necessary layout and details are to be developed by the Contractor keeping in view of the statutory & functional requirement of the plant & facilities and providing enough space & access for operation, use and maintenance.
- The layout and levels of all structures shall be made by the Contractor at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The Contractor shall be solely responsible for the correctness of the layout and levels.
- All necessary statutory clearances shall be obtained by the Bidder prior to execution of work under scope of this specification.
- All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to by the Contractor

2.01.00 **List of Exclusions**

a) Bidder to refer to the plot plan for existing facilities excluded from EPC Contractor's scope of work. Demolition of existing quarters, leveling and grading of the site will be taken up by TSGENCO, however any civil/structural work required to make the existing facilities compatible to the new facilities of proposed plant, shall be within the bidder's scope.

2.02.00 **Terminal Points**

Storm and Plant drainage	As per plot plan
Plant Service Road	Existing Plant Road
Sanitary Facilities	As required
Site Grading	As per plot plan
Site Battery limit boundary/ fencing	As per plot plan
Ash pond	As per plot plan

2.03.00 **Notes**

a) This section shall be read in conjunction with Lead Specification and General conditions of contract.

b) For Architectural requirements of the plant General Specification and Design Criteria for Architectural Work - Volume VII-B and Technical Specification for Civil, Structural and Architectural Work - Volume VII-C of this Bid Document to be referred.

c) In the event, any contradictions, confusion arises for any statement / condition / terms pertaining to design of civil engineering systems, stated elsewhere in addition to this section, the statement furnished in this section shall prevail.

d) In the event, the bidder notice any inadvertent error / mistake published in the specification, the same shall be immediately brought to notice of the Owner.

3.00.00 **CODES AND STANDARDS**

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

3.01.00 **General**

a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Work.

e) IS-1256 : Code of Practice for Building Byelaws.

f) APDSS where ever a) to e) does not speak off.

3.01.01 **Earthwork**

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

3.01.02 **Concrete**

a) IS-269 : Ordinary and low heat portland cement.

b) IS-383 : Coarse and fine aggregate from natural sources for concrete.

c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

d) IS-455 : Portland Slag Cement.

e) IS-456 : Code of Practice for Plain and reinforced concrete.

f) IS-460 : Test Sieves (all parts).

g) IS-516 : Methods of test for strength of concrete.

h) IS-1199 : Methods of sampling and analysis of concrete.

i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.

k) IS-1834 : Hot applied sealing compounds for joints in concrete.

l) IS-2386 : Methods of test for aggregates for concrete (all parts).

m) IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.

n) IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).

o) IS-3414 : Code of practice for design and installation of joints in buildings.

p) IS-4948 : Welded steel wire fabrics for general use.

q) IS-6452 : High Alumina Cement for Structural use.

r) IS-7320 : Concrete slump test apparatus.

s) IS-7861 : Code of practice for extreme weather concreting (all parts).

t) IS-8041 : Rapid Hardening Portland Cement.

u) IS-8112 : High strength ordinary Portland Cement.

v) IS-10262 : Recommended guidelines for concrete mix design.

w) IS-12269 : 53 grade ordinary Portland Cement

3.01.03 **Foundations**

a) IS-1904 : Code of practice for structural safety of buildings : Shallow foundations.

b) IS-2950 : Code of practice for design and construction of raft foundations.

c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).

d) IS 2911 : Code of practice for Design and Construction of Pile Foundation.

3.01.04 **Loading**

a)	IS-875	:	Code of practice for Structural safety of buildings - loading standards.
b)		:	Bridge Rules of Government of India, Ministry of Railways (Railway Board).
C)	IS 4995	:	Criteria for design of RC bins for storage of granular and powdery materials.

3.01.05 **Masonry**

a)	IS-712	:	Building limes.
b)	IS-1077	:	Common Burnt Clay Building Bricks.
c)	IS-1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
d)	IS-1528	:	Methods of sampling and physical tests for refractory materials.
e)	IS-1597	:	Code of practice for construction of stone masonry (all parts).
f)	IS-2212	:	Code of practice for brickwork.
g)	IS-2116	:	Sand for masonry mortars
h)	IS-2185	:	Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i)	IS-2250	:	Code of practice for preparation and use of masonry mortars.
j)	IS-2572	:	Code of practice for construction of hollow concrete block masonry.
k)	IS-2691	:	Burnt clay facing bricks.
l)	IS-3414	:	Code of practice for design and installation of joints in buildings.
m)	IS-3495	:	Methods of tests of burnt clay building bricks.
n)	IS-4441	:	Code of practice for use of Silicate type chemical resistant mortars.
o)	IS-4860	:	Acid Resistant Bricks.

3.01.06 **Doors, Windows and Ventilators**

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

3.01.07 **Roof and Flooring**

a) IS-2204 : Code of practice for construction of reinforced concrete shell roof.

b) IS-3201 : Criteria for the design and construction of precast concrete trusses.

c) IS-2210 : Criteria for Design of R.C. shell structures and folded plates.

d) IS-809 : Rubber flooring materials for general purposes.

e) IS-1195 : Bitumen mastic for flooring.

f) IS-1196 : Code of practice for laying bitumen mastic flooring.

g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors.

h) IS-1237 : Cement concrete flooring tiles.

i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.

j) IS-2114 : Code of practice for laying in situ terrazzo floor finish.

k) IS-2571 : Code of practice for laying in situ cement concrete flooring.

l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping.

m) IS-5766 : Code of practice for laying burnt clay brick flooring.

n) IS-1197 : Code of practice for laying of rubber floors.

o) IS-2441 : Code of practice for fixing ceiling coverings.

3.01.08 **Waterproofing**

a) IS-1322 : Bitumen felts for waterproofing and damp proofing.

b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.

c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.

d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.

e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.

h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

3.01.09 **Soil Engineering**

a) IS-1498 : Classification and identification of soils for general engineering purposes.

b) IS-1892 : Code of practice for sub-surface investigation for foundations.

c) IS-2131 : Method for standard penetration test for soils.

d) IS-2720 : Methods of test for soils (all parts).

3.01.10 **Water Supply, Drainage and Sewerage**

a) IS-404 : Lead pipes

b) IS-458 : Concrete pipes

c) IS-651 : Salt glazed stoneware pipes and fittings.

d) IS-771 : Glazed fire-clay sanitary appliances (all parts).

e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns.

f) IS-783 : Code of practice for laying of concrete pipes.

g) IS-1172 : Code of basic requirements for water supply, drainage and sanitation.

h) IS-1626 : Asbestos cement building pipes, gutters and fittings (all parts).

i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200	:	Method of measurement: Laying of water and [Part-XVI] sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
s)	IS-3486	:	Cast iron spigot and socket drain pipes.
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
v)	IS-1538	:	Cast iron fittings for pressure pipes for water, gas and sewage.
w)	IS-1230	:	Cast iron rainwater pipes and fittings.
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y)	IS-784	:	Prestressed concrete pipes.
z)	IS-1726	:	Cast iron manhole covers and frames.
aa)	IS-5961	:	Cast iron grating for drainage purposes.
bb)	IS-5219 [Part-I]	:	"P" and "S" traps.

cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.

dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.

ee) IS-777 : Glazed earthenware wall tiles.

ff) IS-2548 : Plastic water closet seats and covers (all parts).

gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

3.01.11 **Paving and Road work**

a) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220

d) Practice followed by Indian Road Congress (all parts).

3.01.12 **Earthquake Resistant Design**

a) IS-1893 : Criteria for earthquake resistant design of structures.

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

3.01.13 **Chimney**

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

3.01.14 **Structural Steelwork**

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line.

Part-I : Load and permissible stresses.

Part-II : Fabrication, Galvanizing, Inspection & Packing.

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d)	IS-808	:	Rolled steel beams, channels and angle sections.
e)	IS-813	:	Scheme of symbols for welding.
f)	IS-814	:	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g)	IS-816	:	Code of practice for use of metal arc welding for general construction in mild steel.
h)	IS-817	:	Code of practice for training and testing of metal arc welders.
i)	IS-818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j)	IS-819	:	Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k)	IS-919	:	Recommendations for limits and fits for engineering.
l)	IS-1024	:	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m)	IS-1161	:	Steel tubes for structural purposes.
n)	IS-1182	:	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o)	IS-1200 [Part-VIII]	:	Method of measurement of steelwork and ironwork.
p)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
r)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
s)	IS-1365	:	Slotted counter sunk head screws (dia. range 1.6 to 20 mm).
t)	IS-1367	:	Technical supply conditions for threaded steel fasteners.

u)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	:	Method for tensile testing of steel products.
w)	IS-1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
x)	IS-1731	:	Dimensions for steel flats for structural and general engineering purposes.
y)	IS-1852	:	Rolling and cutting tolerances for hot rolled steel products.
z)	IS-1977	:	Structural steel (Ordinary quality)
aa)	IS-2016	:	Plain Washers
bb)	IS-2062	:	Steel for General structural purposes.
cc)	IS-2074	:	Ready mixed paint, air drying, red oxide zinc-chrome, priming.
dd)	IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
ee)	IS-3613	:	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
ff)	IS-3664	:	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
gg)	IS-3757	:	High strength structural bolts.
hh)	IS-4000	:	High strength bolts in steel structures.
ii)	IS-4759	:	Hot dip zinc coatings on structural steel and other allied products.
jj)	IS-5334	:	Code of practice for Magnetic Particle Flaw detection of welds.
kk)	IS-7215	:	Tolerances for fabrication of steel structures.
ll)	IS-7280	:	Base-wire electrodes for sub-merged arc welding of structural steels.
mm)	IS-7318 [Part-I]	:	Approval test for welders when welding procedure approval is not required.

nn) IS-8500 : Structural steel – micro-alloyed (medium and high strength qualities).

oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.

pp) AWS D.1.1 Structural Welding Code.

3.01.15 **Painting**

a) IS-348 : Specification for French Polish.

b) IS-427 : Specification for Distemper, dry colour as required.

c) IS-428 : Specification for Distemper, oil emulsion, colour as required.

d) IS-1477 [I & II] : Code of practice for painting of ferrous metal in buildings.

e) IS-2338 [I & II] : Code of practice for finishing of wood and wood based materials.

f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

3.01.16 a) Indian Road Congress (IRC) Bridge Codes

b) Indian Railway Standard Bridge Rules

3.01.17 **Environmental Protection**

Chapter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

4.00.00 UNITS AND LANGUAGE

4.01.00 Drawings

- All dimensions will be in SI Units - Metric (English)
- Scales
  - Planning Drawings: Site Layout & Elevations will be at 1:500, Section & Elevation of each building will be at 1:200.
  - Structural and architectural Plans, sections, and elevations will generally be at 1:100 and/or 1:50; for architectural and civil details; 1:1, 1:5, 1:10, 1:20 as required will be used.
  - Site work and yard piping plans will generally be at 1:200, 1:500
- Text will be in English language

4.02.00 Units for Calculations

All calculations will be in SI (English) units.

Length	mm, M
Area	mm^2, M^2
Volume (solids)	mm^3, M^3
Volume (liquids)	mm^3, M^3, liter
Density	kN/M^3
Force	N, kN
Pressure (piping)	Bar
Moment	kNM
Stress	Mpa, N/mm^2
Distributed loads, ground pressures, etc.	kN/M^2

English language will be used in calculations

5.00.00 GENERAL SITE INFORMATION

The site is located within the premises of existing Kothagudem Thermal Power Station which already accommodates 4x60+4x120+2x250+1x500 =1720 MW units. One 800 MW supercritical unit will be installed for augmentation of total plant capacity .

For the proposed 1x800 MW extension unit, main plant, equipments, facilities and green belt will be accommodated in existing 'D' colony of the thermal power station. 230 acres land will be acquired for expansion of existing ash pond for the proposed unit. The existing ground level of the plot is approximately varies from at 85-90 M above MSL.

Meteorological Data	
Site Conditions :	
Annual mean daily maximum temperature	44.7 degree C
Annual mean daily minimum temperature	13.5 degree C
Design Flood Level	Not known
Seismic Criteria	Zone -III
Wind Design	Basic Wind Speed, Vb = 44m/s
Average Annual Rainfall	1124 mm
Maximum Hourly Rainfall Intensity	102 mm

6.00.00 SITE DEVELOPMENT AND UTILITIES

6.01.00 Plant Coordinate System

- The site will be surveyed and coordinates for all points be determined.
- The surveying contractor will establish plant benchmarks and North/South and East/West control lines for control of construction on the plant site. The North/South and East/West control lines will be developed based on grid systems of the existing Plant.
- To facilitate design and construction, a plant grid system and plant north will be established. The plant coordinate system will be laid out based on this grid.
- The plant coordinate system will be indicated on the Plot Plan Drawing.

6.02.00 Grading

The plot of land for the proposed project is graded land with difference in ground level upto 7 meters. Different FGL for different blocks of the plant are shown in the plot plan. However, this is preliminary and contractor has to finalise the levels during detail engineering considering natural contours, successful operation of proposed and existing plants, proper drainage, roadways and other system and utility connectivity.

The existing ground level of the plot is approximately varies from at 85-90 M above MSL. All plant levels referred as RL will be with respect to Mean Sea Level (MSL) and all plant elevations referred as EL will be with respect to Power House Building Ground Floor elevation as 0.0M. The site bench mark will be established by the contractor accordingly.

- The road levels will generally be at 150 mm above FGL
- The finished floor level of ground floor of all the buildings will generally be at 500 mm above FGL
- The top of grout (under side of equipment base/base plate) for foundations and structures outside building at grade will generally be 200 mm above finished grade. The top of grout (under side of equipment base/base plate) for all equipment foundation at ground floor within the building will generally be 150mm above finished floor unless dictated otherwise by mechanical / electrical system layout.
- Base plates for structural steel building columns will generally be sufficiently below ground floor in order to keep enlarged portion of gusseted base below ground. This portion shall be encased in concrete for corrosion protection.

6.03.00 **Drainage**

6.03.01 **General**

Drains shall be designed as a network covering the plant area within the battery-limit of this specification. Attempts shall be made to convert construction drains into main drain as far as practicable. The invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the main/trunk drain under all condition.

The plant shall be provided with gravity drainage systems for the followings :

- Storm water Drainage
- Plant Drainage including Oily Water/ equipment process/chemical waste water
- Sanitary waste/ Foul water Drainage

6.03.02 **Storm Water Drainage System**

Storm water runoff is runoff from plant areas not subjected to contamination and will be discharged to terminal point via new lifting station if required any. Examples of such areas include building roofs, roads, paved areas, stone surfaced areas, grass surfaced areas, and other natural surfaced areas.

Storm water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins, manholes and below grade pipe system to terminal points

For buildings that have a gutter and downspout system, the downspouts will empty to gullies or inspection chambers with sand trap at ground level before discharge to the main drainage system. Drainage from Basements, Cable and pipe trenches will be routed to sumps and connected to the storm water drainage system by pumping system.

The storm water drainage system shall be designed with maximum hourly intensity of rainfall and its duration.

For pitched roof with metal sheeting a minimum slope of 1 (V) to 5 (H) and for flat roof a minimum slope of 1(V) to 50 (H) will be provided for efficient drainage of rain water. The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron pipes will be used below buildings and HDPE pipes will be used for below grade piping drainage system. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

Run-off coefficient for open ground area (unpaved) shall be minimum 0.80 and for paved area and other covered surface including roads the same shall be considered as 1.0.

Design considerations

i) Major drains will be of open type RCC construction with rectangular section and minor drains will be of brick masonry. R.C.C./brick drains shall be covered with perforated R.C.C. pre-cast slab (M-30) of minimum 50mm thickness with edge protection angles at all the side and with the provision of openable galvanized steel grating covers at every 4.0m intervals.

ii) In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness with edge angles on all the corners without perforations and designed for the vehicular loads shall be provided.

iii) In Boiler and ESP area, drains shall be provided with galvanized steel gratings using 6 mm thick flat for both bearing and cross bars with class-1 galvanization. For areas covering vehicular movement, pre-cast covers shall be provided. The width of the pre-cast planks shall be so designed that it can be easily handled during maintenance period.

iv) Suitably designed underground storm water RCC piping on the basis of design loads specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view.

v) RCC pipe culverts/box culverts shall carry drainage under intercepting roads and railway tracks.

vi) Class of RCC pipes shall be decided by Bidder as per design requirement. For pipe drains, concrete pipes of minimum grade – Class NP2 shall be used. However, for road concrete pipes of Class NP3 shall be used and for rail crossing, railway norms shall be followed.

vii) Surface drains shall normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge.

viii) RCC or masonry structures shall be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box/pipe culverts.

ix) Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 1.83 m/sec for brick drain and 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

6.03.03 **Plant Drainage System**

Oily waste water will pass through oil water interceptor and then combined with storm water drainage system for ultimately discharged to terminal point. Oily waste water will include surface run off from transformer compounds, building floors and drains from other oil contaminated areas

Oily waste water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

The contaminated surface water runoff from rain will be designed for maximum hourly rainfall intensity.

The drainage from transformer pit will be stored in a collecting tank and subsequently passed through oil water interceptor before connecting to the storm water drainage system.

The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron oily pipes will be used below buildings and ductile iron cement lined oily line will be used outdoors. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.04 **Sanitary Waste Sewer / Foul Water Drainage System**

The sanitary waste/ foul water will be discharged to gravity fed foul manhole and then to a sewage treatment plant.

HDPE pipes shall be used for drainage. Sewers will be designed for a minimum self-cleansing velocity of 0.70 m/sec and the maximum velocity will not exceed 2.4 m/sec.

Manhole will be provided at every 50 meter along the length, at connection points and at every change of alignment, gradient or diameter of sewer pipeline.

The slope of sanitary pipe within the buildings will equal 20 mm per meter (1:50). Piping outside the buildings will be designed to maintain a minimum self-cleansing velocity with slopes not milder than 1 in 500.

Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organization, Government of India) shall be followed for design purpose.

6.04.00 **Roads**

All new roads, hardstands will be provided to have accessibility to the plant where required and to be connected with the existing road network at suitable points..

- Minimum carriageway and shoulder width shall be as listed below. Shoulders width shall be added to the carriageway widths to obtain minimum roadway widths.

Road Type	Classification	Carriageway Width (m)	Shoulder (m)	Roadway Width (m)
1.	Primary Road (Peripheral)	12.0	2.0	16.0
2.	Primary Road (internal Road)	7.0	1.5	10.0
3.	Accessways	4.0	-	4.0

- All internal roads in Power House area from Switch Yard to Chimney area including roads around Power House shall be Cement Concrete (CC) roads and all other roads within the battery limit of this package shall be water bound macadam with RCC topping on prepared sub grade with 300 mm minimum soling for heavy vehicles.

- All internal roads in Power House area from Switch Yard to Chimney area including roads around Power House shall be Cement Concrete (CC) roads with Vaccum Dewatered Flooring (VDF) concrete and other plant roads with bitumen macadam, water bound macadam base and sub-base shall be as per IRC standards with 300 mm minimum soling. Minimum total thickness of black topping (premix carpeting) shall be 50 mm in 2 layers of 25 mm each. Bituminous topping of all plant roads shall be done after completion of plant construction.

  For premix carpet, recommendation of IRC-14 shall generally be followed. Spreading of black topping work shall be carried out using mechanical paver / finisher.

- RCC pavement with Vaccum Dewatered Flooring (VDF) concrete shall be provided at areas requiring parking facilities.

- A detailed CBR test shall be carried out as per the procedure outlined in IS:2720 (Part XVI).

- For road crossing of pipelines supported on ground, the pipe top level generally shall not be more than 100mm above the top of the road. Suitable hump with slope not steeper than 1:30 shall be provided for the roads. Necessary modification shall be done by the Bidder for the roadside drains.

- Roads shall be designed as per IRC-37:1984 “Guidelines for the design of flexible pavements”. California Bearing Ratio (CBR) method shall be adopted for the design of roads.

  The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for maneuvering of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Transverse camber of 1 in 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding ground level.

  Shoulders shall be formed with gravel on par with the road level.

6.04.01 **Pavement/Footpaths in Other areas**

Paving as required will be provided using interlocking pre-cast concrete block.

Surface Treatment

a) **Main plant Area**

The entire area from Power House to Chimney shall be paved with reinforced cement concrete with Vaccum Dewatered Flooring (VDF) concrete and sloped to drains.

b) **Transformer Area & Switchyard**

Oil cooled equipment, such as transformers, shall be located within concrete basins filled with HBG metal. The individual basins shall be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains shall be adequate to remove full discharge from deluge system used for fire control. Transformer Yard shall be paved with reinforced cement concrete with Vaccum Dewatered Flooring (VDF) concrete.

Switchyard area excluding the internal access roads shall be paved with ash bricks on edge over a layer of 100 mm thick lean concrete (M10) as specified elsewhere of this specification. Anti-weed chemical treatment as per specification to be done as required.

c) **Cooling Tower Area**

Paving in this area shall be as specified in Volume VII-D Technical Specification for Natural Draft Cooling Tower

d) Necessary pavement, surface treatment shall be done for Coal handling, DM plant and PT plant.

6.05.00 **Fencing**

6.05.01 Fencing with gates shall be provided around transformer yard, Switchyard, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

The PVC coated chain link shall be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip shall be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm shall be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands shall be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts shall have two stay posts and every tenth post shall have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.

Toe walls either of brick masonry with bricks of minimum 75 kg./sq.cm. Crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level.

Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing.

All gates shall be of structural steel of minimum 3.75 metres clear width for single lane access road and 7.75 m clear width for double lane access roads. The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS: 513.

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

6.06.00 **Electrical Conduit Protection**

All electrical conduits (duct bank) laid under ground will be encased in concrete. Reinforcements will be provided in the encased concrete at main traffic crossings and other areas requiring access during construction based on the final design and the Construction Sequence.

6.07.00 **Pipe and Electrical Concrete Trenches**

Generally pipe or electrical cables will be taken through concrete trenches with precast concrete covers. Suitable drainage and working arrangement inside trench shall be provided. The trench cover shall be provided with edge protection angles and lifting devices. Suitable inserts and opening shall also be provided as per service requirement. Precast covers for trenches shall be light weight and shall not weigh more than 65 Kg. each.

CW pipe line will be constructed by providing suitable supporting pedestals at 10 mts interval and burring the pipe in a trench after being rapid coated with bitumen bound approved coating. Pipe bed will be made of 500 mm thick, well compacted sand and sand fill will be packed at both sides upto 50% diameter of the pipe, followed by filling up rest of the portion by good selected earth so as to have min. 1.5m of earth cushion over the pipe. While crossing the road & railway suitable road/rail structure will be considered as per relevant IRC codes & loading specified elsewhere in this specification.

Generally all cableways outside building will be either through concrete underground duct banks housing PVC pipes or overhead on pipe rack except for HV cables which will be through trench. However, any trenches located outside buildings will project 150 mm above the finished formation level to avoid ingress of storm water. The bottom of trench will be sloped suitably for draining out the collected water into sump pit.

6.08.00 **Electrical Manholes**

Cast-in-place, reinforced concrete manholes will be provided as required to meet the electrical system construction requirements.

Drainage sumps will be included in all manholes to improve ability to remove water from manholes. The use of portable pumps to remove water from manholes will be considered.

7.00.00 GEO-TECHNICAL CRITERIA

7.01.00 General Description of Soils

Owner has carried out preliminary geotechnical investigation in the proposed power plant area. Representative borelog details along with the recommendations given in soil report shall be considered by the Contractor for reference only. Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit. In any case, the contractor has to carry out detailed geo technical investigation after the award of contract, through approved/reputed agency and to submit geotechnical investigation report with recommendations for the Owner's review and approval. The recommendation given in approved final report becomes binding on the Contractor. The Contractor is not eligible to increase his cost or demand any extension of time if the final report is in variance from preliminary report furnished by the Owner. The preliminary geotechnical investigation report is available with the owner and will be furnished for reference on request.

7.02.00 Ground Water and Dewatering Requirements

GWT is located at about 2.5M to 3.5M below the existing ground level shown in contour map attached as Annexure 1 . HHFL is about 88M. However, the bidder has to determine the exact GWT during detailed engineering based on soil investigation at his scope.

7.03.00 Excavation Criteria including De-watering

Unless otherwise specifically mentioned in geo-technical report this shall be followed.

Excavation shall be carried out in all types of soil including soft soil, soft moorum, hard moorum, soft rock, hard rock etc.

After excavating to the founding level, the exposed sub-grade will be inspected and proof rolled, if required, prior to placing lean concrete for subsequent placing of rebar, setting forms and placing concrete. Soft or yielding areas will be excavated and replaced with compacted backfill. Bearing grades will be cleaned and kept dry prior to placing concrete.

Excavations will be maintained and protected against earth collapse from natural causes or subsequent construction work and will have stable slopes, as appropriate, to meet local soft conditions and safety codes.

Dewatering wherever is necessary has to be done at bidder's cost only.

7.04.00 **Backfill Criteria**

Site-excavated material free from unsuitable material or non-expansive bottom ash or pond ash may be used as backfill against pit and sump walls and as structural fill beneath foundations if suitable.

Off-site material if required to be used for backfill, it will be fully tested and installed as per the project specifications.

7.05.00 **Compaction Criteria**

Fill and backfill material will be as recommended in the Geo-technical Report and as required by project specification requirements.

Material used as structural fill (load bearing) beneath structures and roads will be compacted to a minimum of 95% of the maximum dry density (modified Proctor). Moisture content of material will not deviate more than 2 percent of optimum.

Material used as backfill (non load bearing) around structures will be compacted to a minimum of 90% proctor density. Natural moisture content of material will not deviate more than 3 percent of optimum.

8.00.00 **LOAD AND STABILITY CONSIDERATIONS**

8.01.00 Loads and their Combinations

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. Any structure which carries Indian Railway Loading or is situated in the vicinity of Railway Lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc. All structures and foundations shall be designed for most critical combinations of dead load, live load, equipment load, pipe and cable tray loads, crane loads, wind loads, seismic loads, temperature loads and special loads as applicable as per requirement of relevant codes and standard.

A. **Dead Loads**

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, silo, bins and hoppers shall be measured at full capacity for this purpose. Hung loads and the contents of tanks, silo, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials		**Unit weight**
Plain cement concrete	:	24.0 kN/cum
Reinforced cement concrete	:	25.0 kN /cum
Structural steel	:	78.5 kN /cum
Brick work	:	19.0 kN /cum
Cement plaster	:	21.0 kN /cum
Floor Finish, screed concrete, Plaster	:	24.0 kN /cum
Steel grating floor	:	0.5 kN/sq.m
Checkered plate cover	:	0.5 kN/sq.m
False floor	:	1.0 kN/sq.m
False ceiling in control and Electric rooms	:	0.4 kN/sq.m
Metal decking	:	0.15 kN/sq.m
Insulated metal siding	:	0.25 kN/sq.m
Non insulated metal siding	:	0.15 kN/sq.m
Masonry unit with plaster on Both sides :		
230 mm nominal thickness	:	4.95 kN/sq.m
115 mm nominal thickness	:	2.47 kN/sq.m
Coal	:	12.0 kN /cum
Fly Ash	:	16.0 kN /cum
Bottom Ash	:	16.0 kN /cum

B. **Live Loads**

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary. Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) **All Buildings**

a) Roofs :

Inaccessible roof	:	0.075 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof where equipments are placed	:	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof without equipments	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).

b)	Stairs & Platforms	:	5.0 kN/Sq.m
c)	Corrridors	:	5.0 kN/Sq.m
d)	Removable gratings, chequered plates, walkways etc.	:	5.0 kN/Sq.m (for supporting beams) 7.0 kN/Sq.m (for grating/ chequered plate)
e)	Office, Laboratory, Conference rooms and other non-plant areas etc.	:	5.0 kN/Sq.m

ii) **Power House Building**

a)	Ground Floor		
	Unloading Bay	:	35 kN/Sq.m
	Other areas	:	20 kN/Sq.m
b)	Mezzanine Floor	:	15 kN/Sq.m plus hung loads.
c)	Operating Floor		
	T.G. Lay-down Area	:	25 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
	Other Areas in Turbine Hall	:	25 kN/Sq.m plus hung loads
	Rotor removal area beams shall also be checked for half the rotor load at the center of the beam		
	Other Areas in Operating Floor	:	15 kN/Sq.m plus hung loads
d)	Cable Spreader Floor	:	7.5 kN/Sq.m plus hung loads
e)	All other floors	:	15 kN/Sq.m plus hung loads
f)	Due to anchoring of conductors on "A" row column	:	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Sheilding Wires) OR actual load furnished by equipment supplier

iii) **Mill Building, Bunker and coal handling system**

a)	Ground Floor	:	25 kN/Sq.m
b)	Feeder Floor	:	15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
c)	Tripper Floor	:	10 kN/Sq.m + hung loads + 0.5 KN/Sq.m (dust load).

d)	Coal Weight	:	8.0 kN/Cu.M for storage volume calculation
		:	12.0 kN/Cu.M for load calculation

iv) **Auxiliary Buildings**

a)	Ground Floor	:	10 kN/Sq.m
b)	Cable Spreader Floor	:	7.5 kN/Sq.m
c)	Pump House Operating Floor	:	10 kN/Sq.m
d)	Office Floor	:	5 kN/Sq.m
e)	Switchgear room	:	15 kN/Sq.m
f)	All other Floors	:	10 kN/Sq.m

v) **Non Plant Buildings**

a)	Floors with equipment	:	10 kN/Sq.m
b)	All other floors	:	5 kN/Sq.m

vi) **Underground Structures/Trenches/pits**

Minimum surcharge shall be 10 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement, 20 kN/Sq.m surcharge shall be considered. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 10 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

vii) **Covers for Trenches**

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall be considered.

Trench cover at entry to buildings and at road crossings, shall be designed for class AA & Class A loadings as per IRC whichever is critical at centre. The trench cover at other location shall be designed with a surcharge of 1.0 T/Sq.M or a concentrated load of 1.0T at centre.

viii) **Roads**

Design of roads shall be in accordance with Indian Road Congress standard .

ix) **Road Culverts**

Road culverts shall be designed for Class `AA' loading (wheeled and tracked both) & to be checked for Class `A' loading as per IRC standards.

x) **Reduction in Live Load**

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, 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 major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings shall be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings shall include Hydraulic Testing loads.

iii) Air & 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.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

D. **Wind Loading**

Wind loading shall be in accordance with Indian Standard Code IS:875 (Part 3):1987 for a basic wind speed of 44 m/s upto a height of 10 metres above mean ground level.

Terrain Category-4, Class-C shall be considered for all structures.

E. **Seismic Loading**

The site falls in Zone-III as identified in the map in IS:1893-2002. Analysis and design of structures to resist the seismic forces will be established in accordance with the recommendations of IS: 1893 (Part IV): 2005. Importance factor to be considered is 1.5 for all structures. Ductile detailing of RCC structures will be as per IS: 13920.

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.

Mean Daily minimum ambient temperature during coldest month of the year = 13.5° C

Mean Daily maximum ambient temperature during hottest month of the year = 44.7° C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

G. **Steam Piping Load**

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

H. **Earth Pressure Load**

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of sub-structure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

I. Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows:

Crane loads

a) For vertical force, an impact factor of 25% of the maximum crane wheel load

b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail

c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

a) Impact factor of 10% of lifted load of hoist for monorail and support design

b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories

J. Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing so far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented by bidder to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

K. **Other Loads**

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

Dispersion of load in any direction through soil shall be as per IS:8009 (Relevant part).Dispersion of load through concrete shall be considered at an angle of 45 degree with horizontal from the edge of contact area.

L. **Thrust Load**

Thrust blocks shall be designed against the thrust load from pipe lines considering the test pressure in the pipe lines.

M. **Ash Silo**

The following densities shall be considered for design of Ash silo

a) For volume calculation of bottom ash silo : 6.5 kN/cum

b) For volume calculation of fly ash silo : 7.5 kN/cum

c) For load calculation of both types of silos : 16.0 kN/cum

The ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be considered in design.

8.01.01 **Load Combinations**

While designing consideration shall be given to the following load combinations:

i) DL + LL

ii) DL + LL + PL + Equip ± TL

iii) DL + LL + PL + Equip + Cb + CtLA± CS ± TL

iv) DL + LL + PL + Equip + Cb + CtLB± CS ± TL

v) 0.9*DL ± EL (for DL only) ± TL

vi) 0.9*DL ± WL1 ± TL

vii) 0.9*DL ± WL2 ± TL

viii) DL + LL + PL + Equip + Cb + Ct ± EL ± TL
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

ix) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL1) ± TL

x) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL2) ± 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 from left to right
WL2	=	Wind load from right to left
EL	=	Earthquake load
TL	=	Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) - 1987 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) - 1987. All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.

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.

8.01.02 **Load Combinations for Underground Structures**

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under ground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

8.01.03 **Other loading considerations**

Wind and seismic forces shall not be considered to act simultaneously.

For the design of main plant structures during seismic condition, the Deaerator Feed Water Tank shall be considered full up to operating level. However, for other load combinations, Deaerator Feed Water Tank in flooded condition shall be considered.

`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 R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns.

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Ultrasonic pulse velocity tests shall be carried out for the top decks of all machine foundations viz. TG deck and substructures, BFP Foundation, ID fan, FD fan, PA fan and Mill foundations to ascertain the homogeneity & integrity of concrete.

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 (like Mill Bay structure, Trestles etc.) 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.

8.02.00 **Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS codes, subject to the following minimum values.

a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

b) Factor of safety against sliding shall be 1.5 minimum.

c) Factor of safety against uplift due to hydrostatic forces shall be 1.25 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

The design calculations and respective drawings in AUTOCAD format shall be submitted accordingly.

9.00.00 BUILDING DESIGN CONCEPT

9.01.00 Framing System and Method of Analysis

Analytical model of the building structure will be either two dimensional or a three dimensional space frame. Analysis of models shall be done using STAAD Pro Software.

For Steel frame structure, it will be either (1) Simple frames with vertical diagonal bracings at column lines in both directions and horizontal bracing at the roof and major floor levels or (2) Moment resisting frame in transverse direction with braced frames in longitudinal direction. For Concrete frame structure, it will be Moment resisting frame in both directions.

For composite framed building moment resisting frame will be provided in transverse and longitudinal direction with reinforced concrete columns and steel roof truss/girder framing members in transverse direction and reinforced concrete framing members in longitudinal direction.

9.02.00 Method of Design

The Strength design of Steel members will be done by working / allowable stress method using IS:800 (Latest Edition) where as the Strength design of Concrete members will be done by limit state method using IS:456 (Latest Edition).

Un-braced lengths for steel beams will be as per code or as determined from following criteria

- Beams supporting concrete slab with shear connectors / compression flange embedded in RCC slab will be considered continuously supported.
- Beams supporting metal roof deck attached with welding washers plug welded will be considered continuously supported.
- Beams supporting metal deck or concrete slabs formed with metal decking will have an un-braced length based on framing member locations.
- Beams supporting grating floor will not be considered continuously supported.
- Beams which are part of a truss will use the distance between panel points as their un-braced length or, if the panel has connecting major members, the un-braced length will be based on the distance between panel points or connecting members, whichever is the shorter distance.

- In grating floor, for two parallel, interconnected beams, the beam with greater load will be considered as un-braced and the other beam as braced at the points of interconnection

- In grating floor, for three or more parallel, interconnected beams with loads of same order or magnitude, all beams will be considered as braced at points of intersections. When the beams are loaded disproportionately, the un-braced lengths will be determined as stated above.

- **Acceptance Criteria for required depth**

  - For steel members, minimum depth equals to 1/24 of span unless clearance requirements will dictate lower depth in certain areas.

  - For Concrete members, minimum depth equals to 1/16 of span unless clearance requirements will dictate lower depth in certain areas.

  - Members will be framed into members of equal or greater depth

10.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES

a) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456.

Concrete tanks/water retaining structures shall be designed in accordance with the recommendation of IS-3370.

b) For reinforcement detailing IS:5525 and SP:34 shall be followed. Ductile detailing of RCC structures will be as per IS: 13920.

c) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

d) **Liquid Retaining Structures**

RCC water retaining structure like storage tanks, reservoirs, etc. shall be leak proof and designed as uncracked section in accordance with IS:3370 (part I to IV) by working stress method.

Substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS:3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS: 3370 (part I to IV) by working stress method.

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. No pressure relieving devices shall be permitted in underground structures.

In all liquid retaining structures leak-tightness shall be ensured and guaranteed. To achieve the same, methodology in design and construction in the way of providing PVC water bars at construction/expansion joints and/or injection grouting, usage of admixture in concrete or any such method should be adopted. The sequence of construction shall also be specified on drawings showing construction joints.

e) **Water reservoirs**

The in plant raw water reservoir will be compartmentalized to ensure de-sludging/maintenance of any section without affecting plant operation. With a view to conserve water LDPE of approved make of 500 microns lining as per IS 3370 will be provided on bed and sides.

Raw water reservoir will be provided with concrete slab. It is also to be attended with necessary methods of base preparation works for controlling the abnormal/uncontrollable seepage, if any.

Raw water storage Net capacity 1,50,000 M^3 with 1.2M free board is to be adopted.

Level gauge with approach steps shall be provided.

Outlet pipe with sludge valve shall be provided and stop gates at inlet may be provided.

The surface shall be provided with anti-weed treatment.

Hand railing shall be provided.

Floating matter trap gates at inlet shall be provided.

With a view to conserve water, the fire water reservoir will be provided with concrete slabs on top as protective cover, LDPE film lining will be provided on bed and sides to prevent seepage loss.

10.01.00 **Foundation design**

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.

a) **Foundations resting on virgin soil**

All Major foundation shall rest either on pile or on virgin soil. Preliminary Geo-Technical investigation for the proposed site has been carried out by the owner and the report is available with the owner. The same will be furnished to bidder on request and for reference only.

Bidder however, shall carry out necessary geo-technical investigation at all relevant locations before deciding the type of foundations. Bidder shall decide the type of foundation based on the load from structure and the outcome of bidder's soil investigation.

b) **Foundations resting on fill material**

All grade slab, trenches, pits, electrical trenches & duct banks, manholes and other lightly loaded equipments & structures with bearing pressure not exceeding 50kN/Sq.M will be founded on this founding medium. A minimum of 0.5M below foundation will be of compacted sub-grade to a min. of 95% of the max. dry density (modified Proctor).

- **Minimum Founding Depth**

The bottom of foundations on virgin soil will not be less than 1.0 meter from finish grade level unless specified otherwise in geo-technical investigation and recommendation. Foundations for Misc. Skids and other minor supports will be kept minimum 300 mm below finished grade unless greater depth is required by site specific requirements.

For steel columns of Power House building, Boiler, Mill and Bunker building, ESP, etc., Top of RCC foundation 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.

10.01.01 **Heavy Equipment Foundations for Turbine Generator, Coal mills, Turbine & Motor driven pump and large fans**

RCC design shall be done by working stress method for all machine foundations.

All block foundations supporting rotating equipment resting on hard strata shall be designed using the elastic half space theory.

Bidder's design scope of work shall consist of the following :

a) Finalization of the general arrangement layout and levels of foundation for Turbine Generator, Pulverizer, Turbine & Motor driven pump and large fans based on the equipment layout considering limitations of available space and any other layout constraints.

b) Submission of design criteria for approval

c) Submission of the following information as provided by equipment supplier and as applicable depending up on approved design criteria:

1. Loading diagram showing static and dynamic loads and points of application of loads.

2. Operating speed of m/c; Critical speed of m/c.

3. Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.

4. Location of C.G. of machines in all three axes.

5. Mass Moment of Inertia.

6. Allowable amplitude/velocity of vibration at machine bearing points.

7. Temperatures in various areas during operation.

d) Analysis of the top deck, design and detailing of reinforcement.

e) Submission of all design calculation, all loading diagrams, General arrangement drawings, embedment drawings and reinforcement drawings for the foundations under the scope for the approval of the owner.

f) Carrying out revisions / alterations based on the comments of the owner. In addition to hard copies, the final soft copy of all drawings (in autocad and pdf format) and documents shall also to be submitted.

g) Submission of construction methodology / casting sequence and any special requirement. Concreting of STG columns shall be cast in single pour and methodology including temperature control shall be got approved by the Engineer.

A. Design considerations for major equipment foundations that supported on conventional machine foundations:

- Design of foundations shall be done in accordance with relevant parts of IS-2974. Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.

- Foundations shall be isolated from adjacent structures for vibration control.

- Natural frequencies of structures and components shall be away from the running speed of equipment as per frequency separation criteria and amplitude criteria laid down in IS:2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied. A fatigue factor of 2.0 shall be considered for dynamic forces / due to normal unbalance. For design of foundation of large fans etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

- All block foundations resting on pile shall be designed using the pile-soil interaction.

- The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.

- Tension in piles shall not be allowed for any combination of loads. For Foundations of rotating major equipments, the natural frequency and allowable vibrating amplitude/velocity shall be as per criteria furnished by the Vendor. In absence of such criteria, the foundation shall satisfy the criteria set forth in IS 2974, DIN 4024 and VDI 2056.

B. Specific considerations for foundations where equipments are supported on vibration isolation system :

- **General Requirement**

  The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck which would support the equipment. Complete Vibration Isolation System shall be provided for the foundations of Boiler Feed Pumps, Coal Mills, ID, Fan, FD Fan, PA Fan and all other rotating equipment except Turbo-generator.

  Steel helical springs and viscous dampers shall be provided by GERB or equivalent manufacturer with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 500 MW.

- **Material (Design & Supply)**

  Steel helical springs and viscous dampers shall consist of

  i) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

  ii) Frames for pre-stressing of spring elements.

  iii) Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks and hand operated pumps shall also be provided.

  iv) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs.

- The objective of designing the supporting arrangement for any rotating equipment shall be so that the vibration level is maintained as minimum as possible under all operating conditions. Accordingly, respective rotating equipment shall be supported on RCC deck slab which in turn shall rest on vibration isolation unit consisting of steel helical springs and viscous dampers, which in turn shall be supported on RCC supporting structure. The above design shall form part of this specification.

- The spring units shall have definite stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 30% of vertical stiffness. The stiffness shall be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 to 5 Hz.

- The damper units or spring-cum-damper units shall be of viscous type offering velocity proportional damping. The damper units shall be suitable for temperatures ranging from 0 to 50 deg. C. The damping resistance of individual damper units shall be such that the designed damping is provided using reasonable number of units. Damper shall have damping resistance ranging from 40 kN sec/m to 750 kN sec/m.

- The sizes of the spring units, damper units and spring-cum-damper units shall be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.

- The steel helical springs and viscous dampers shall be designed for ensuring “fit and forget” guarantee.

- It shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads.

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

- Tension in piles shall not be allowed for any combination of loads.

- **Manufacturing & Testing**

  Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub-vendor/supplier. For this purpose, the contractor/sub vendor shall submit the detail program for approval of engineer and take up the manufacturing/testing after approval of such program. The program shall include :

  i) Manufacturing schedule and quality check exercised during manufacturing.

ii) Detail of test to be carried out at the manufacturing shop with their schedule.

iii) Special requirements, if any, regarding concreting of top deck.

iv) Complete step-by-step procedure covering the installation and commissioning of the spring system.

v) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.

vi) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.

vii) Checklist for equipment required at each stage of erection.

viii) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

ix) Bill of materials (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.

x) Any other details which may be necessary to facilitate design and construction of the foundations/structures.

- The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedures shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

- **Erection, Commissioning and Supervision**

  i) Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre stress in spring elements, making final adjustments and alignments etc. all shall be done a specialist supervisor of supplier/sub vendor trained for this purpose.

ii) The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.

iii) The contractor shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".

- **Realignment of Spring System**

  If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of Commercial Operation of the machine, the same shall be done by the contractor as and when asked for at no extra cost of the Owner.

- **Acceptance Criteria**

  Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed :

  i) General workmanship is being good and as recommended by the manufacturer are approved by the Engineer.

  ii) Tolerances are within the specified limit

  iii) Material test certificate (MTC) is in compliance with the applicable codes/standards.

  iv) Bought out material is from the approved manufacturer/vendor

  v) Bought out material is matching with the approved sample

- **Codes and Standards**

  Latest revision of following codes shall be used for the design of the spring supported foundations :

IS : 456 Code of practice for plain and reinforced concrete.

IS : 2974 Code of practice for design and construction of machine foundations.

IS : 1893 Criteria for earthquake resistant design of structures

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses

DIN : 2089 Helical compression springs out of round wire and rod : calculation & design

DIN : 2096 Helical compression springs out of round wire and rod : quality requirements for hot formed compression springs.

VDI : 2056 Criteria for assessing mechanical vibrations of machine.

VDI : 2060 Criteria for assessing the state of balance of rotating rigid bodies .

C. **Steam Turbine Generator Foundation Design Criteria**

- The Steam Turbine Generator shall be rigid RCC frame structure supported on pile foundations wherever necessary. The concrete outline and embedments/inserts/pockets detail shall be supplied by machine manufacturer. The turbine generator pedestals shall be designed to meet the manufacturer's deflection criteria and other recommendations.

  Analysis and design of the Steam Turbine-Generator (STG) foundation shall be carried out in accordance with relevant codes IS: 2974 Part-3 and IS: 456 and/or manufacturer's requirements.

  The loads to be considered for static analysis and design shall consist of dead weight of the machine and foundation, machine power torque, condenser loads under normal operating condition, Equivalent static load due to machine unbalance, thermal elongation forces, forces due to one sided operation of the condenser, forces due to condensate pump failure, vacuum loads, forces due to piping, frictional forces at machine sole plate level for turbine, generator and condenser, temperature distribution under operating condition, failure loads of turbine (blade unbalance/loss of blade/bowed rotor), failure loads of generator (short circuit loads), seismic loads due to generator, turbine and condenser and erection loads.

Detailed static and dynamic analysis shall be performed both for normal operating condition & abnormal condition such as short-circuit, accidental loss of blades & earthquake. At any event of time any two transient loading (short circuit, seismic) need not be assumed to act in the same direction simultaneously. Seismic analysis shall be done by response spectrum method.

The dynamic analysis shall consist of free-vibration and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS-2974 and or VDI 2056 and/or as required by machine manufacturer whichever is more stringent shall be satisfied.

Elaborate mathematical model shall be considered. Due regard shall be given to pile stiffness in lateral and vertical direction and pile-soil interaction.

Stress for thermal load, shrinkage and creep shall be properly accounted for. Minimum reinforcement shall be governed by IS-2974 as well as IS-456.

For appropriate load combinations or any other information, stipulations of IS-2974 shall be satisfied.

D. **Boiler Feed Pump Foundation**

TDBFP & MDBFP foundations shall consist of RCC top deck supported on steel helical springs and viscous dampers inside main power house. In case the top deck is located at operating floor/mezzanine floor or any other floor level based on bidder's approved layout, the springs / viscous dampers shall be supported on a group of structural steel columns-beams grid which shall be rigidly integrated with the Main Power House structural frame.

In case the TDBFP & MDBFP foundation is envisaged to be located at ground floor of Power House, these foundations shall consist of top deck supported on steel helical springs & viscous dampers which shall in turn be supported on RCC sub-structure. This is generally a RCC block foundation resting on either on piles or raft as per the design based on soil strata. Concrete outline and details of pipe sleeves/pockets/embedments shall conform to the data provided by machine manufacturer.

E. **PA, FD, ID Fan and Mill Foundations**

These foundations shall consist of top deck supported on steel helical springs & viscous dampers which shall in turn be supported on RCC sub-structure. RCC substructure shall be supported below ground level on pile or soil as per the design based on soil strata. (RCC foundation with provisions for pockets and cut-outs for bolts and electrical cables shall be as per vendor's outline drawing. The fan foundations shall be provided with detachable roof for protection of fans.

F. **Minor equipment Foundations**

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably as specified elsewhere in this specification.

10.01.02 **Open Foundations**

a) In case open foundations are adopted, the following shall be adhered to :

Minimum width of foundation shall be 1.0 m.

Minimum depth of foundation shall be 1.0 m below NGL.

b) It shall be ensured that all foundations of a particular structure/ buildings/facility shall rest on one bearing stratum, i.e. either overburden or rock.

c) Wherever the intended bearing structure is weathered rock but the actual stratum encountered during foundation excavation consists of both overburden soil and weathered rock at founding level, under such cases either the foundation shall be lowered completely into the weathered rock or the overburden soil upto the weathered rock level shall be removed and built up through PCC up to designed foundation level.

The net allowable bearing pressure values to be adopted for design upon Owner's approval shall correspond to total permissible settlement as mentioned under para "permissible settlement of foundations" or the permissible settlement from functional requirement, whichever is more stringent.

d) Permissible settlement of foundations: The total permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 13063 and from functional requirements, whichever is more stringent. However, total settlement shall be restricted to the following :

Item	**Settlement Criteria**
Steam Turbine Foundation	Maximum total long term vertical settlement after interconnecting systems are complete and the unit is placed in operation shall not exceed 25mm or limit specified by equipment manufacturer.
Boiler area foundations and Stack foundations	1. The allowable overall settlement of foundation shall not exceed 25mm/ vendor requirements
	2. Max allowable differential settlement of foundation shall not exceed 8.0 mm./ vendor requirements
Transformer foundation (including oil fill)	1. The allowable overall settlement of foundation shall not exceed 25mm / vendor requirements.
	2. Any additional long-term settlements after bus duct connections are made and transformer placed in service should not exceed 50mm
Turbine Building foundations	1. The allowable overall settlement of foundation shall not exceed 25mm. 2. Max allowable differential settlement of foundation shall not exceed 8 mm.
Other building and Structures foundations.	1. The allowable overall settlement of foundation shall not exceed 25mm. 2. Max allowable differential settlement of foundation shall not exceed 8 mm.
Miscellaneous Electrical Equipment foundations.	1. The allowable overall settlement of foundation shall not exceed 25mm.
Misc. Mechanical Equipment • Boiler Feed Pump • Lube Oil Skid • Other major equipments	The allowable overall settlement of foundation shall not exceed 25mm.

Item	Settlement Criteria
Flat Bottom above Ground Storage Tanks	Uniform Settlement : • Vertical settlement after filling, hydro-test shall not exceed 25mm.at perimeter unless flexible shell nozzle connections used. Differential Settlement of Center with respect to Edge • The center of the bottom plate floor shall not exceed the settlement of the edge by more than diameter/90.

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced / reviewed accordingly in consultation with Owner.

10.01.03 **Pile Foundations**

In case piles are adopted, following shall be adhered to :

a) The pile foundation shall be of RCC, Cast-in-situ bored, precast/cast-in-situ driven pile as per IS: 2911. 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 and 300mm for precast 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 EPC Contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter 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) and accepted construction methodology. The construction methodology shall be submitted by the EPC Contractor 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
Lateral
Uplift
} Minimum of 3 Nos. in each mode.

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).

g) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

i) Vertical - 1.0 % of the total number of piles provided.

ii) Lateral - 1.0 % of the total number of piles provided.

The routine tests on piles shall be conducted upto 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).

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 EPC Contractor 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). The EPC Contractor 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.

10.01.04 **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 pilling 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 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. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.

iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. 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 shall be disposed off by the EPC Contractor as per the instructions of the Owner up to a lead of about 5 km crow fly distance from the plant site.

vi) CBR tests for flexible pavement design shall be carried out by the EPC Contractor after earth filling has been completed, if applicable.

vii) The storage tanks shall rest on flexible tank pad resting on an open/shallow foundation or pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency having wide experience in execution of similar work. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Owner. In addition to the above, in case of an open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which shall establish complete bearing with the foundation fill.

After the tanks have been erected, hydro testing shall be done. Subsequent upon hydro testing of tank, the differential settlement.

10.02.00 **General Requirements**

- **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 (non-suspended)	150 mm
Water Retaining slabs / walls	200 mm
Cable / pipe trenches / underground pits / Launder walls and base slab	125 mm
All footings (including raft foundations)	300 mm
Width of beam	150mm
Parapets	125 mm
Sunshades at edge	75 mm
Pre-cast louvers / fins	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	75 mm
Paving	150 mm
Basement walls and base slab	200 mm
Silo / bin walls	150 mm
Underground reservoir Below ground water table	200 mm
Above ground water table	150 mm

From fire resistance point of view minimum fire rating of 2 hours shall be considered where fire hazard is expected and minimum thickness of reinforced concrete members shall be as per fig 1 and table 16a of IS 456 or specified above, whichever is higher.

- **Concrete Cover**

  Following minimum clear concrete cover to steel reinforcement will be provided.

A.	**Substructure Work**	Bottom	Sides	Top	Ends
i)	Foundation	75	50	50	50
ii)	Columns, Pedestals, Grade Beams/Tie Beam	50	50	50	50
iii)	Trenches, Pits, Walls, Duct Bank etc. in contact with				
	Earth	50	50	50	50
	Water	50	50	50	50
	Others	25	25	25	40
iv)	Equipment Foundations	50	50	50	50
v)	Slab on Grade	25	50	25	50
B.	**Super structure Work**				
i)	Columns	-	40	-	-
ii)	Beams	35	35	35	50
iii)	Slabs/Walls	20	20	20	40
iv)	Lintel, Chajja, Bands etc.	20	20	20	25
v) vi)	Pre-cast Concrete Silo shell side cover	20	20 30	20	20

- **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 supplied by vendor	:	as per vendor's data subject to minimum as specified above

Foundation levels for some columns may be changed suitable to accommodate underground services, pits, trenches etc.

- **Ground floor slab-on-grade**

  Ground floor slab-on-grade shall be RCC with Vaccum Dewatered Flooring (VDF) concrete construction laid over minimum 100mm thick lean concrete. Minimum 250mm thick graded stone (63 mm 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 or hydraulically compacted sand fill as specified elsewhere in this specification.

- **Stairs, Platforms, Ladders and Handrails**

  All internal stairs, platforms and walkways shall either be of RCC or GI gratings construction. All outdoor stairs, platforms and walkways shall either be of RCC or minimum 40mm thick grating. Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 3.0 mm for a single flight. . All stairs shall have a maximum riser height of 125 mm and a minimum tread width of 250mm. Minimum width of stairs in all buildings shall be 1200 mm.

  Hand railing comprising of posts 1000 mm (min.) high not exceeding 1.5m (max) c/c, shall be provided around all floors/ roof openings, projections, balconies, walkways, platforms, steel stairs etc. All hand rails and posts shall be 32NB heavy duty GI pipes as per relevant IS Codes and shall be galvanized with class-1 galvanization (as per IS-277) shall be provided for all structural steel stair cases and external RCC stairs. Hand rail will be provided with one horizontal pipe at mid-height and continuous flat iron toe guard at bottom. For all internal RCC stair cases in buildings, stainless steel hand railing shall be provided. For stainless steel handrail refer relevant architectural specification.

  Steel cage ladder shall be hot dip galvanised. Stringers shall be of angles 90x90x10 with a minimum clear distance of 400 mm in-between. Rungs shall be of 20 mm diameter mild steel rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable lateral stays. The ladder and its connection shall be designed for a minimum load of 200 kg at any location. Cage shall start from a height of 2.5 m above the base of ladder.

11.00.00 DESIGN OF STEEL STRUCTURES

a) Structural steel design shall be carried out as per the National Building Code with specific consultation to IS-800 working stress method unless noted otherwise. Design of structures in electrical substation shall be as per IS-802.

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) Vertical bracing members which are connected to the beam shall be analyzed for all the vertical loads which the beam is subjected to along with lateral loads.

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

Design of base plate shall be based on the design pressure on foundation which shall not exceed the following:

i) Pedestal in concrete grade M20 ……..5.0 N/mm^2

ii) Pedestal in concrete grade M25 ……..6.25 N/mm^2

iii) Pedestal in concrete grade M30 ……..7.5 N/mm^2

e) 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 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 unless specified otherwise.

f) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice for use of metal arc welding for general construction in mild steel and IS-9595 - 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 relevent IS codes and standard practice. The bare wire electrodes for submerged arc welding shall be as follows

Filler wire: AWS-A-5.17-EH14
Flux shall be agglomerated type of classification
AWS-A-5.17-F7A2EH14

g) All structural steel members for substation shall be hot dip galvanised in accordance with IS-4759. The fasteners shall also be galvanised in terms of IS-5358. Galvanizing of steel structure shall be done after all fabrication work is completed. Zinc coating of galvanized surface of structural members and threaded fasteners shall as recommended in IS:4759. 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. All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633.

h) Shop primer paint shall be single coat of epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimar Paints Ltd.). The surface preparation shall be done after sand blasting in accordance with IS: 1477 (Part I & II) – Code of Practice for Finishing of Ferrous Metals in Buildings. Second coat of primer shall be applied after erection and final alignment of the erected structures. Two or more coats of epoxy paint of approved shade and quality shall also be applied after erection. Total Dry film thickness of the finished paint shall not be less than 110 microns.

i) All welding electrodes shall be of Low Hydrogen type conforming to IS:814 and shall be EB5426H3JX type. All electrodes, flux, wire etc. shall be of ADOR Welding Ltd.,or ESAB India Ltd., or D & H Secheron Electrodes Pvt. Ltd or Modi electrodes or equivalent as approved by Owner.

If submerged arc welding is used, the bare wire electrodes shall be as follows :

Filler wire	:	AWS-A-5.17-EH14
Flux	:	agglomerated type of classification AWS-A-5.17-F7A2EH14

j) 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.

k) 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: 25% of the total length, Dye penetration shall be carried out to the root run.

Butt weld

Dye Penetration Test : 100% of the total length, Dye penetration shall be carried out to the root run after back gouging

Radiographic Test: 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. Minimum 300mm length shall be spot radiographed. When radiograph is not possible ultrasonic test shall be carried out after grinding the surface.

100% radiography test shall be carried out for the plates of 32mm thick and above.

25% radiography test shall be carried out for the plates below 32mm thick.

100% radiography test shall be carried out of the crane girders and bunker girders irrespective of thickness of the plate.

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.

l) **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 drawings) or 0.5 times of the web thickness which ever is more for I section. Weld shall be double fillet.

All welds shall 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.

Erection joints shall be provided with suitable splice plates as per design after conducting the relevant weld tests for the welded joints. 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.

11.01.00 **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 utilises 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 m^2) 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.

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

All indoor gratings shall be electro forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 4mm. All gratings shall be hot dip galvanized.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and through shear connection.

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange shall not be permitted. Bearing edges of crane girders shall be machined.

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, forces from pipe lines etc.). The structures shall be adequately rigid to carry the forces from the pipelines at anchor points without undue deflection so that the pipe lines are really anchored at the anchor points.

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

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

11.02.00 **Permissible Deflections**

The permissible deflections of various steel members under normal load 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 / 250 subject to a maximum of 6 mm
f)	Coal conveyor gallery bridges:		Span/450

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 / 325
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 level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm

g)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height/4000 limited to maximum of 10 mm
h)	Coal Handling Trestles	:	Height/1000

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

11.03.00 **Minimum Thickness of steel elements**

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment (Exposed to open air i.e., to Rain; Contact with Soil, Coal, ash, Contact with drained liquid or contaminated water, acid/alkali etc.) shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

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

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

11.04.00 **Minimum Sizes of steel elements**

For Joists	:	I - 150
For Channels	:	MC - 100
For Angles	:	L 50 x 50 x 6
Gusset plates	:	8mm thick

The flange width of purlins supporting light weight concrete slab	:	65 mm
The flange width of purlins supporting roof sheeting and wall cladding	:	50 mm.
Width of steel rolled section connected to other member	:	50 mm.
The depth of beams for platform	:	125 mm.

11.05.00 **Slenderness and Depth Ratio**

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

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

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

12.00.00 **STRUCTURAL MATERIALS**

Following materials shall be used in design and construction of the structure and foundation:

12.01.00 **Structural Steel**

12.01.01 Structural steel shall conform to Grade A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction, steel conforming to Grade B (Killed and normalized) of IS: 2062 shall be used except for crane girders where Grade C (Killed and normalized) (IS: 2062) steel shall be used. All structural steel plates and sections shall be of Main producer such as “SAIL” or “TATA STEEL” or “RINL” or “JINDAL” make or vendor approved by owner.

12.01.02 Structural pipes conforming to IS 806 (YST 25)

12.01.03 Structural hollow sections (square & rectangular) conforming to IS:4923

12.01.04 Pipes of hand rail conforming to IS:1161 (Medium class Grade YST=240)

12.01.05 Plates, Flats, Ordinary steel washers conforming to IS:2062 (Grade A, B & C).

12.01.06 Steel Gratings – Carbon steel conforming to IS:2062.

12.01.07 Chequered plates (6 mm thick) – Carbon steel conforming to IS:3502.

12.01.08 Anchor Bolts, Studs or Threaded Bars – Mild Steel of grade 4.6 conforming to IS:5624.

12.01.09 Connection Bolts – All High strength connection Bolts shall be of grade 8.8 conforming to IS:1367 and shall be supplied conforming to IS:3757. All mild steel connection bolts shall be of grade 4.6 conforming to IS:1367.

12.01.10 All nuts shall be of heavy duty hexagonal type and shall be compatible with the bolts.

12.01.11 All nuts & washers for high strength bolts shall conform to IS:6623 & IS:6649 respectively.

12.01.12 Washers for mild steel bolts shall be of mild steel conforming to IS:5369/IS:5372 or IS:5374 as the case may be.

12.01.13 Welding Electrodes – Low Hydrogen electrodes conforming to IS:814.

12.02.00 **Concrete**

12.02.01 **Cement**

All cement shall be Fly ash based Portland pozzolana cement conforming to IS:1489 (Part-1).

Ordinary portland cement conforming to IS:8112 (43 grade) / IS 12269 (53 grade) shall necessarily be used for the following structures :

i) TG foundation top deck and sub-structure

ii) Major machine foundations such as PA/FD/ID Fans, Pulverizers, TDBFP AND MDBFP

iii) Chimney shell

iv) Shell and racker columns of NDCT

v) Structures requiring grade of concrete of M25 and above excluding water-retaining structures.

As an alternative to Fly ash based Portland pozzolana cement, Fly ash can be added to ordinary Portland cement (Grade 43/53). Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS: 3812 (Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix and subject to maximum of 25% replacement of cement. Detailed design mix shall be carried out by the bidder and approved by the consultant / owner.

PP Cement shall be used only for miscellaneous buildings like storage sheds, concrete pavements. For all other works OP Cement (grade 43/53) shall be used.

The cement procured from mini plants will not be acceptable.

12.02.02 **Grade of Concrete**

The following minimum grades of concrete as per IS-456 shall generally be used :

Sl. No.	Class	Grade of conc.
1.	i) Plain cement concrete used for screeds and mud-mat ii) Subgrade filling	M15 M7.5
2.	Paving in main plant area, Slab on grade, Duct bank	M20
3.	i) Reinforced concrete for super structure and foundation & Chimney raft	M25
	ii) Reinforced concrete for water retaining structure	M25
4.	Pre-cast concrete	M30
5.	Reinforced concrete for foundation of TG, Mill, BFP & Fan foundations	M30
6.	TG top deck, chimney foundation	M30
7.	chimney shell	M40
8.	Piles	M30

Detailed design mix shall be carried out by the contractor and approved by the Engineer.

All underground trenches, basement and water retaining/conveying system structures shall have plasticiser cum waterproofing cement additives such as 'SIKA', 'FOSROC' make or equivalent conforming to IS:9103. In addition, limits on permeability as given in IS:2645 shall also be met with. Addition of admixtures should not reduce the strength of the concrete below the specified strength in any case. In case of water leakage during hydro-test or otherwise, additional chemical injection grouting treatment shall be applied for repairing the leakage with no cost implication to the owner.

All concrete surface in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing up to 400mm above finished grade level. Storm water drains shall not be provided with bituminous paint.

12.02.03 **Concrete Reinforcing Steel**

Reinforcing bars shall be TMT bars of grade Fe415 or Fe500 conforming to IS-1786 and Mild Steel bars conforming to IS : 432 (Grade I) of either of “SAIL”, “TATA STEEL” and “RINL”. However, for TMT re-bars above 25mm diameter shall be of ‘SAIL’, ‘TATA’ or ‘RINL’ only.

Furthur, vendor approval is required for additional vendors other than approved vendors of APGENCO.

14.07.00 **Natural Draft Cooling Tower**

All civil and structural work for Natural Draft Cooling Tower shall be as specified in Volume VII-D Technical Specification for Natural Draft Cooling Tower.

15.00.00 **MISCELLANEOUS REQUIREMENTS**

Further to all requirements described in the preceding clauses, the following criteria shall be strictly complied with pertaining to analysis, design, layout & construction of aforesaid power plant.

15.01.00 Dense concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structure such as basement, pump houses, water-retaining structure, cable & pipe trenches etc., for achieving water tightness.

15.02.00 All joints, including construction and expansion joints for the water retaining structure shall be made watertight by using 230 mm (minimum) PVC ribbed water stops with central bulb. However, kicker type (Externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting.

15.03.00 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc., as per IS-6313 and other relevant standards.

15.04.00 Minimum 100 mm thick lean concrete shall be provided below all underground structure, trenches etc., to provide a base for construction.

15.05.00 All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab.

15.06.00 Each building shall be provided with minimum 1.0m wide reinforced concrete paving all round unless specified otherwise. All buildings shall have a slab offset of 300 mm from the wall. Paving shall be sloped to provide a rapid run off of rainwater away from building.

15.07.00 The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

The steel columns below ground floors shall be encased in concrete up to minimum 250 mm above finished floor.

15.08.00 **Stability of structure**

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

15.09.00 **Grouting**

The method of grouting the column bases shall be subject to approval of Purchaser and shall be such as to ensure complete uniformity of contact over the whole area of the steel base. The Contractor shall be fully responsible for the grouting operations.

Grouting shall be done with 'SIKA' or Conbextra GPX-2 of `Fosroc' 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.

15.10.00 Steel chequered plates and gratings shall be hot double dip galvanised.

15.11.00 Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, and any other places where breakage of corners of concrete is expected. Precast cover slabs shall have edge protection angles at top and bottom on all the four sides along with lugs.

15.12.00 All drains inside the building shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be used in place of steel grating.

15.13.00 All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off from platform.

15.14.00 For all buildings suitable arrangements for draining out of water collected from equipment blow-downs, leakage, floor washing, fire-fighting etc., shall be provided for each floor and connect the drain pipes to drains at ground level..

15.15.00 Duct banks consisting of PVC/GI conduits for cables shall be provided with concrete filling conforming to IS-456. The minimum depth of top of duct bank from grade level shall be 500mm. Duct banks for cables shall be sealed using approved fire retardant sealing compound.

15.16.00 All sand filling shall be compacted to minimum 95% of the relative density.

15.17.00 All buildings shall have framed super structure. All walls shall be non-load bearing infilled panel walls.

15.18.00 Increased cover to reinforcement for all RCC structures as per IS-456 - 2000 shall be provided to withstand corrosive environment if there be any.

15.19.00 All gates and stop-logs shall be of structural steel, which shall be hot double dip galvanised.

15.20.00 All mild steel parts used in the water retaining structures shall be hot double dip galvanised. Galvanising shall be checked and tested in accordance with IS-2629.

15.21.00 A screed of concrete layer not less than 100 mm thick shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure.

15.22.00 For steel pipes encased in concrete, concrete encasement to steel pipe shall be with M20 grade of concrete and shall be of minimum 150 mm thickness all around pipe.

15.23.00 Ramps for building entrance shall be cast- in-situ RCC slab designed as a slab spanning over supports or rigid pavement resting on subgrade provided that the thickness of slab and the property of subgrade shall be such to ensure of its being treated as rigid pavement. The slope of ramps shall not be more than 20°. Minimum thickness of slab shall be 150mm.

15.24.00 Only sewage and drainage pipe may run below road. Any other pipe like system water pipe may run beyond 1.0m from the edge of road along its longitudinal direction.

15.25.00 Provisions of safety, health & welfare according to factories Act shall be complied with. These shall include provision of continuous walkway of minimum 750 mm wide along the crane girder at crane girder level with side handrails on both sides of the building, access staircase at one end and cage ladders at two ends to EOT crane walkway from operating floor, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

15.26.00 Trenches located outside building shall project at least 150mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit.

15.27.00 All cables & pipes in outlying area shall run above ground over steel trestle or other supporting structures for easy inspection and maintenance except in transformer yard area and some other local area where the same can run in RCC trenches or through duct-banks. However laying of cables shall be as per approved Electrical layout.

A minimum clearance (clear head room) of 8.0m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In case of rail crossings the above mentioned clearance shall be maintained from the top of rail level and not from the top of formation level. In other areas the clear height shall be 3.0m (minimum) from ground/grade level.

All trestles shall be provided with continuous walkway of minimum 750 mm width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc.

A barrier of suitable height shall be constructed near rail/road crossing, so as to prevent the approach of cranes (having height more than 8.0m) etc. upto the pipe/cable rack trestles.

Four-legged trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals or at corners as per layout. Crossover, operating platform & necessary thrust resisting arrangement at pipe bend shall be provided as required.

15.28.00 For all trench structures, the bottom slope perpendicular to the run of the trench shall be minimum 1 in 200 and shall be minimum 1 in 500 for slope along the length of the trench.

15.29.00 Top of CW pipes shall be minimum 1.50 m below grade level/ formation level.

15.30.00 For open horizontal drains, reservoirs concrete lining of minimum M15 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.

15.31.00 Provision for fire proof doors, nos. of staircases, fire separation walls etc., shall be made according to the recommendations of TAC /LPA regulation.

15.32.00 All roofs shall be provided with access through a staircase. All roofs shall be provided with water proofing treatment.

15.33.00 Fly ash bricks shall be used for masonry work. Bidder shall ascertain himself at site regarding the availability of fly ash bricks of minimum 75 Kg/sq.cm compressive strength before submitting his offer. Bidder shall take approval of APGENCO for usage of bricks other than fly ash bricks.

15.34.00 Ground floor slab for the buildings and paving shall be of minimum 150 mm thick VDF concrete laid over 100 mm PCC and 230 mm (minimum) soling unless specifically mentioned otherwise. The reinforcement shall consist of minimum 8 mm diameter bars at 200 mm c/c of grade Fe 415 at top and bottom in both direction.

15.35.00 Windows of ground floor of all buildings shall be provided with heavy duty MS grill for MS windows and Aluminium grill of 7.5mm thick weighing 3.58Kgs/1Sqm for aluminium windows.

16.00.00 **STATUTORY REQUIREMENTS**

The Civil Engineering and building work shall comply with all appropriate statutory requirements including all current Building Control regulations, and with all planning or other conditions as required by the relevant local, state, and National authorities.

16.01.00 The contractor shall provide full general arrangement drawing (Civil, Structural & Architectural) of all buildings, structures and facilities to the Owner for comment. The Contractor shall not proceed with these drawings further without such comment. Any work carried out by the Contractor using drawings unacceptable by the Owner shall be at the Contractor risk.

16.02.00 The Contractor shall seek and obtain all necessary approvals and detailed planning consents outstanding at the time of placing the contract and shall be responsible for all necessary liaison with such authorities to obtain the same and for the payment of due fees for such approvals.

16.03.00 The Contractor shall obtain approval from the appropriate authority regarding the safe means of escape in the event of fire or other hazard before relevant construction work proceeds. As a minimum, the Contractor is required to ensure that the work shall comply with all statutory requirements including:

i) Central Government/State Government - for all building control regulation

ii) State factories act - For Safety, health & welfare, use of hazardous substance

iii) Central and State Pollution Board - For limits on pollution levels.

iv) Central Water Authority/State Irrigation Department - For Water obstruction/supply for withdrawal of water from local source, location of Intake pump house / Jack well.

v) State Water & Disposal Department - for waste & Foul Water disposal.

vi) Ministry of Environment - for all matters relating to environment.

vii) Ministry of Railway - for all matters for railway line construction.

viii) Tariff Advisory Committee - for regulation concerning fire safety/means of escape.

ix) Aviation Authorities - for clearance of tall structure like stack etc.

x) State Public Work Department - for regulations on Civil work/road work.

xi) Ministry of Forestry - for deforestation, if any, for site development.

16.04.00 The Contractor shall make due allowance for all necessary negotiation/ administration required and the time needed to obtain these permission and approvals in his programme. Failure to obtain such approvals in a timely manner shall not be a reason for extension of the programme.

17.00.00 **DOCUMENTS TO BE SUBMITTED**

17.01.00 **Design Documents**

A. The Contractor shall be required to prepare a `Basis of Design' for each Elements/Structures of Civil Work expanding on the information given in the specification. The `Basis of Design' shall include the following:

i) A concise description of the form of Structure considered.

ii) A statement of salient assumptions made.

iii) Codes of practice and references used

iv) A description of the design approach

v) Detail Calculations including Computer inputs & results with conclusion.

vi) Design/working drawings showing necessary details

The design and drawings shall be addressed to Owner / consultant appointed by the Owner for scrutiny of the same at least 12 weeks prior to the commencement of the relevant construction activity. The comments of the consultants shall be considered for effecting further revision.

B. The submission shall be in accordance with dates set down in Contractors civil work design and construction programme.

C. The Contractor shall be required to carry out at his own cost, any rectification, alteration or replacement of work progressed within 12 weeks of submission of the design basis and drawings and resulting from engineers comments on the design submission.

D. Acceptance of the Contractor `Basis of Design' calculations or drawings by the Owner shall not relieve the Contractor of any of his obligations to meet all the requirements of the Contract or relieve the Contractor's responsibility for the correctness of design and safety of the structure for the design life of the plant. The Contractor shall make any changes in the design/drawing in the form of DCN without any financial implication, which are necessary to make the work comply with the contract.

E. The Contractor shall prepare detailed calculations for all structure / elements in accordance with cl. no.17.01.00 A. The Contractor shall also make available any additional calculations, other than routine structural calculation, as requested by the Owner during the period of Contract.

F. In addition to Geotechnical investigation report, the Contractor shall arrange and make available any other reports and investigations the Owner deems necessary for safety & stability of plant. The investigations shall be carried out in any standard laboratory of repute and as recommended by the Owner. All laboratory tests shall be carried out in the presence of Owner's engineer.

G. In the event, the Contractor adopts any patented method of design and Construction, not popular or practiced in this country; the Contractor shall sought prior approval of Owner in writing. The Contractor shall forward appropriate literatures, documents, certificates, case histories etc., to establish the viability of the method.

H. The bidder shall submit the tender with a schedule of proposed sub contractors for different construction packages (if necessary), structural consultants, (if any), any hired personnel for expertise, along with their name address, etc. and shall obtain approval of the Owner before fixing up of sub-contractor with required credentials for a particular work.

I. Each calculation document shall include the following

i) Contractor's name

ii) Package identification (if any)

iii) Designer's name/initials

iv) Checker's name/initials

v) Reference No.

vi) Index

vii) Date & Revision No.

viii) Revision identification mark

ix) Detail calculations including computer input data and output.

J. Calculation packages shall preferably be bound at A4 size sheets. All numerical analysis shall be done through computer. The bidder shall have either their own system or have access in other system outside their premises.

The Contractor shall be a bonafide license holder of any software package used in this project. Any in-house developed software may also be used subject to the approval of the Owner through validation with standard computer programme. Any pirated & unlawful use of software shall not be permitted. The Contractor shall furnish:

i) Name of Software

ii) Developing Agency

iii) A write-up/overview of the programme. As supplied by the copyrighter.

iv) Relevant documents verifying users right for using this software in this country.

K All construction drawings furnished by the contractor shall consist of total quantity of concrete (grade-wise), reinforcement steel (diameter-wise) and structural steel (section-wise).

17.02.00 **Construction Documents**

Based on approved design drawing, detailed drawings for construction will be prepared by the Contractor. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall accompany each detailed drawing. For structural steel work the Contractor will prepare detailed fabrication drawing along with bill of materials.

Six (6) copies each of selected or all detailed drawings/ fabrication drawings as decided by Engineer for all structures /bill of materials need be furnished to Owner/Consultants along with bar bending schedule.

17.03.00 All working & construction drawings shall be drawn by CAD system, and shall be issued in A0/A1 size. The drawing shall include:

i) Name of Project, Owner, Consultant & Contractor.

ii) Title of the Drawing

iii) Drawing No. Issue Date, Revision No.

iv) Statement for Revision

v) Revision Identification Mark

vi) Release Status

vii) Designer/Checker’s/Draughtsman's name/initial

17.04.00 The Contractor, who shall maintain an upto date drawing & document register, shall monitor drawing & document issue. This register shall list all drawings & documents used in the design and construction for civil and structural work. The drawing register shall be a controlled document and shall be kept updated/revised and shall be issued on A4 size sheets.

17.05.00 All drawings, design documents, reports, correspondence pertaining to civil structural work shall be in `English Language'. Documents in any other language shall be translated in English before submitting to Owner.

18.00.00 **LAYOUT**

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

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

19.00.00 **WORKMANSHIP**

Workmanship shall be of the best quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lanning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer’s specifications.

20.00.00 TEMPORARY WORK

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

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

21.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE OR EXISTING STRUCTURES

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

22.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

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

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

VOLUME : VII-B

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORKS

2.00.00 DESIGN REQUIREMENTS

2.01.00 Architectural Concepts

a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.

b) Main plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehendible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.

c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

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

e) Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipments so that the proper co-ordination with other agencies can be taken up at appropriate time.

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 shall have minimum 1.0m sill height and bottom of lintel height shall be 2.5m from finished floor level. 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) All the buildings shall be architecturally designed to meet the National Building Code.

d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect Statutory requirement and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of national/ international repute having experience in similar kind of works. The consultant shall evolve the design philosophy and shall present it in the form of presentation drawings, prospective views, 3-D Models & detail drawings. All architectural drawings shall be prepared under responsibility of an Architect. The Architect should be registered under Council of Architecture. The registration certificate of the architect should be produced by the bidder during bid submission.

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) At the inception of the detail engineering the bidder should submit the architectural concept of the overall plant with 3D views & colour scheme of Plant & Non-plant buildings for selection of the owner. The selected concept shall the vernacular of the project to bring harmony all over the plant site.

2.02.00 Plant Buildings

2.02.01 Powerhouse Building

Powerhouse shall be of structural steel framed with RCC floor and part Brick Wall and balance part double skin insulated colour coated galvalume sheets cladding construction. Operating floor being the heart centre of Powerhouse shall be designed as a very impressive floor having high quality finish, material and appropriate ambience.

External facade shall be with full brick thick wall up to approximately 3.0m high, plastered and painted. From 3.0m-upto roof external façade shall be clad with factory fabricated Rockwool / PU insulated metal cladding on A Row & Gable ends, on C Row and any other external exposed surfaces, single skin metal sheet cladding over brick work shall be installed where brick work is technically required. Fire Wall facing towards Transformer yard, shall be minimum 6.0M high and minimum 250mm thick RCC wall as per Fire Prevention regulation. Single skin metal cladding similar to the Top sheet of Insulated Metal Cladding used for other part of the facia shall be applied over the Fire wall to match the overall elevation treatment.

Sufficient natural light and ventilation has to be ensured for every part of the building unless prevented due to technical reasons. Operating floor may have large glazed area made with Structural glazing system. At Crane girder level windows on A Row, B Row and gable ends shall be provided. North Light system shall be provided on roof of power house building at suitable locations so that sufficient natural light can be obtained at TG Hall floor.

Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.

Minimum one number Down comer shall be provided at each grid column.

All cable spreader floors shall have proper slopes and provision of fire emulsifying system for drainage.

Steel columns within fire hazardous areas like electrical room, Main control room and switch gear room shall be encased with brick work or concrete. All steel columns shall have 150mm high concrete base to ensure proper floor finishing work and to protect the column base.

Minimum 2.1m high headroom clearance has to be maintained at every part of the building.

Vertical Head room clearance shall be maintained as per industry factories Act.

Sufficient headroom shall be provided in cable galleries.

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. If the height between false ceiling and bottom of beam is more than 2.1M then steel grid system (1.2M X 1.2M span) with catwalk to be provided to support the false ceiling system and human access respectively.

Minimum 1.5M wide passage is to be marked on the floor as safety exit route. Such passages shall lead to Fire-escape staircases or fire-safe zones. Doors of fire-hazardous rooms or areas shall open towards safety exit passage. All external doors shall open towards outside. Fire escape staircases shall be located as per fire-code and TAC.

2.02.02 Mill & Bunker Building

This shall be of steel framed structure having single skin metal cladding to clad Tripper floor only. The colour and pattern of the sheeting should match the overall ambiance of Power Island. Sufficient natural light and ventilation should be provided for tripper floor. Provision of roof access through stair should be made.

2.02.03 Other Plant Buildings

Structures of Other plant buildings shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of each building shall be maintained.

3.00.00 ARCHITECTURAL REQUIREMENTS

3.01.01 Roof Insulation and Ventilation

The roof of buildings which are recommended by HVAC department for over deck insulation shall be insulated with rigid insulating board.

Extractor fans will be provided over roof of turbine hall for ventilation. For ventilation requirements relevant section of the specification shall be referred.

3.01.02 **Roof Waterproofing**

Roof water proofing treatment shall be as follows :

a) Roof water proofing treatment shall be as follows :

i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR of BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –
ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in

both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

iii) For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

a) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.

b) APP membrane shall conform to Conforms to: UEAtc,ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.

c) Technical Data

- Chemical Base — APP modified Bituminous Polyester
- Thickness — 4mm
- Unit weight — 4.40 kg/m2(According to UEAtc)

d) Mechanical / Physical Properties

- Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
- Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
- Resistance to water pressure - No leakage - (According to DIN52123)
- Carrier (Polyster) weight- 180 g/m2

- Softening Point - 145 oC - (According to ASTM D36)
- Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
- Tear resistance (L/T) N-170/180- -(According to UEATc)
- Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
- Heat Resistance- No Flow at 100oC-
- Resistance to Aging after 2000 hrs (Weather –O-Meter)- No Delamination- (According to ASTM D4799)

e) Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.

f) Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.

g) All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.

3.01.03 **Partition Wall**

All intermediate walls shall be full brick thick wall in 1:4 cement sand mortar. Half brick thick wall in 1:4 cement: sand mortar with RCC band 100 mm thick & with 2 nos. 8 mm dia rod in every eighth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided or shall be provided with structural steel member at minimum 2.5 m clear height with MS inserts/lugs for anchoring in brick work shall be provided. Similarly MS lugs shall be provided on the structural member at spacing 500/600 mm on vertical face for proper anchorage for brickwork, lugs embedded in concrete and suitable vertical structural member at maximum 5m c/c. Full glazed partition in anodized aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area.

3.01.04 **Plastering**

Exterior & rough side of interior brick wall	20mm thick minimum sand faced plaster in two layers with 1:4 cement sand mortar of 12mm thick first layer and 1:3 cement sand mortar with 8mm . Where external finish will require rich plastering for special finish plaster shall be of 1:4/1:3.
Interior wall	12 mm thick with 1:4 cement-sand mortar.
Ceiling	6 mm thick with 1:3 cement-sand mortar shall be provided to all exposed ceilings.

3.01.04 **False Ceiling**

Aluminium pre-painted/Powder coated false ceiling, 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.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong, in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

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. Wherever under-deck insulation is required the insulation shall be as per specification mentioned elsewhere in the specification.

3.01.05 **Special Finish**

a) The main entrance of powerhouse, Service Building, control room and other important areas shall have high quality finish to floors, walls, ceilings etc.

b) Main stairs and landing shall be equally treated.

3.01.06 **Doors**

a) Generally factory made hollow metal (steel) double plate flush doors shutters comprising of two outer steel sheets with pressed steel frame shall be provided for plant and utility areas.

b) Factory made Solid core wooden flush doors in teak wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/ electrical depending on the size of opening.

d) Special areas like control rooms and other special area shall be provided with minimum 15 micron pre-coated i.e. colour anodized aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside.

g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.

h) 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.

3.01.07 **Windows & Ventilators**

In Powerhouse building, full glazed windows and ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 6 mm thick clear wired/laminated glass where required from safety point of view.

For operating floor of Power House, structural glazing may be considered as an important façade element. All windows and ventilators shall meet the requirement of industrial windows and Ventilators.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided suitably in panels not exceeding 1200 mm wide. The window area shall be so decided as to allow adequate natural ventilation and light.

Note: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Contractor before execution.

3.01.08 **Landscaping**

Generally the natural contour shall be retained except where modifications needed for drainage or other technical reasons. Rockeries, appropriate trees, shrubs, ground cover, lawns along with landscape furniture, sculptures, fountains, decorating/ornamental fencing, electric lights & fittings, etc. Shall be provided to create a visually pleasant environment. Special landscaping shall be made around main entrances of powerhouse and other important buildings. Irrigation facilities shall be provided for all green areas.

The plant area shall be covered under Landscaping. Minimum 33% or as per recommendation of MoEF (whichever is higher), of plant area shall be kept as Green Belt. Some of the plantation area shall be fenced suitably as per the choice\advise of the Owner. Trees for formation of green belt of minimum width 100 M for segregation of CHP area from the raw water reservoir will be chosen to match with prevailing landscape in the adjacent areas. Names of some of avenue trees are given for selection, which are "Arjun, Ashoke, Elengi, Amaltus, Gulmohur, Mohua, Sirish, Margose, and White Ceden" and of other species suitable to the local environment. Special landscaping shall be made around main entrance of Power House, Service Building, Main Gate Complex. The area shall be covered by shrubs and seasonal flowers. Plantation for green belt shall commence immediately after the mobilisation of the Contractor at site, so that trees are sufficiently grown at the time of commissioning. The plants shall be maintained for a minimum period of one year after planting, and dead plants, if any shall be replaced. The Contractor shall also lay and commission the irrigation scheme for the landscaped areas which shall include supplying and installing pumps to draw water from the sewage and effluent treatment plant and pump into the system at required head, supplying and laying buried GI pipes of adequate capacity with associated fittings and control valves and sprinklers of approved

design for distribution and sprinkling of water to various disposal points. A nursery has to be set up in the area to cater to the need of plantation. Some beatification work like decorative landscaping, rockeries, fountain, and lily pond shall be provided at locations to be suggested.

The Contractor shall furnish detail drawing schedule for landscaping prepared by experts in the respective discipline. The work shall be taken up duly after approval of the Owner.

Arboriculture and avenue plantation all along roads suitable to environment shall be provided.

3.01.09 **Facilities in Buildings**

Adequate toilet and drinking water facilities shall be provided for personnel working in each floor of building. Each floor of building shall have toilet facilities both for Gents and Ladies. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code.

However minimum 1 Water Closet with cistern, 1 washbasin with mirror, towel rail, soap case, 1 urinal shall be provided in each toilet.

Each floor shall have drinking water facility connected through potable water with water cooler.

3.01.10 **Potable Water System and Service water Plumbing**

This system for various buildings 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: (Pt. XVI) Laying of water and sewer lines including appurtenant items.

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 yard sanitary sewer system.

Service water shall be supplied to water closets, urinals, sinks, and other plumbing fixtures.

3.01.11 **Roof Drainage Systems**

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

a) Roof Drain Heads/ dome strainer

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 all 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.

Slope of roof for drainage should be not less than 1 in 100.

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. 150mm dia. Medium duty G.I pipe of TATA, Jindal or equivalent approved make shall be used.

3.01.12 **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) 4 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 anodization.

e) 6mm thk. Wired / laminated glass shall be used for windows / ventilators at higher level for safety.

f) 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.

3.01.13 **Sealant**

Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 shall be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 or polystyrene filler board of HD100 of Supreme or equivalent shall be used as joint filler. All joints around exterior doors, windows, and expansion joints, etc. shall be sealed for proper water- lightness.

3.01.14 **Damp Proof Course**

40 mm thick 1:1.5:3 concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.01.15 **Plinth Protection**

Minimum 1000 mm wide concrete plinth protection having thickness of 150mm with PCC M20 and over 150 mm soling, along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be connected to station main drainage system..

3.01.16 **Miscellaneous Metal Railing**

a) For main stair & lobby of Powerhouse building upto operating floor, around large openings at operating floor, main stair of Service building, Administrative building shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of grade SS-304 and of approved design to meet the functional requirement as well as very good aesthetic appearance. Other hand railings of Power house building shall be MS Galvanised hand railing with 40 mm NB (medium) main post and 32 mm NB (medium) as horizontal rails. With toe guard shall be provided.

b) For Service Building & Administrative building, ESP control room, switch yard control room, chemical house & other all control rooms stainless steel railing with SS posts & decorative SS handrails or CP teak wood rails shall be provided.

c) For any other RCC For any other RCC stairs of non-plant buildings shall be MS Galvanised hand railing with 40 mm NB (medium) main post and 32 mm NB (medium) as horizontal rails with toe guard shall be provided.

d) For plant & non-plant buildings, unless otherwise indicated in the specification the post and handrails of stairs, railings, etc. Shall be of 32 mm dia NB medium class G.I. pipes as per IS-1239-part (I).

3.01.17 **Painting**

Exterior Masonry Surface	:	Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint similar to "Apex Ultima", "Weathergurd"/ "Weathershield" over plaster. Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade. Aluminium composite panels (ACP) may be used to accentuate certain portion of the façade or certain element of the façade as the case may be.
Exterior Steel Work	:	Two finish coats of high built epoxy finish of 90 microns each over two primer coats of Zinc silicate 50 microns each shall be applied on exterior steel work.
All Woodwork	:	Synthetic paint over a coat of primer.

All Internal Steel Work	:	Epoxy Paint over approved primer
Steel in contact with acid /alkali	:	Acid/Alkali/Chemical resistant paint
Interior Office Spaces Control Rooms, All A.C. Areas	:	Acrylic emulsion paint over 3 mm thick white cement putty punning.
Other Plant Buildings	:	Interior masonry surfaces of all plant buildings shall be painted with synthetic enamel paint up to 1.50 m height from floor level and balance portion with Acrylic Distemper paint of two coats over one coat of primer over white cement putty.
Fire Door	:	Post Office red shade shall be provided.

3.01.18 **Miscellaneous Work**

a) Counter tops in kitchen, Washbasin, pantry & similar areas shall be polished granite over RCC slab or Kota stone top.

b) Pavements, walkways, etc. Shall be 50/ mm or of standard thickness thick anti-skid interlocking concrete pavers

c) Anodized aluminium grill of heavy duty of thickness not less than 7.5mm and weight not less than 3.58Kgs/Sqm shall be provided for aluminium glazed windows. But in specific cases, M.S. grills shall be used as per approved design for security purpose made of 25 mm X 6mm M.S. Flats / 12mm – 20mm M.S. square bar of approved design shall be provided to suit security requirements.

d) R.C.C. stair railing shall be with 20 mm square M.S. Bar balustrades with suitable M.S. flats & anodized aluminium / CP Teakwood handrails shall be provided. Stainless steel pipe railing in specific areas shall be used.

e) For RCC main stair and landing of powerhouse building shall be of Kota stone and white marble strip combination, RCCstair of Service Building & Administrative building shall be of white marble/combination of Baroda green and pink marble with all edges and nosing moulded.

f) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.

g) Suitable arrangement of floor drain with trap shall be provided in floor where spillage of water may occur.

h) RCC staircase shall be provided in main entrance of Turbine building, Facility building and other important buildings. Turbine hall staircase shall be provided with Structural steel work

i) Covered car parking stand for 20nos cars module with minimum 50mm thick coloured interlocking cement concrete tile flooring over reinforced concrete hard standing and module for 50 nos. Two-wheelers & cycle parking stand shall be provided as per requirement at the desired location of the owner. Structure shall be of RCC. The structure shall be aesthetically harmonious.

j) Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel. The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment. Location and area of such access flooring shall be as per electrical requirement and Electrical GA Drawings.

k) Doors, windows and rolling shutter in all buildings shall have sun-shade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 450 mm for windows. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided. For recessed type shed minimum 450 mm offset shall be provided.

l) North Light provisions on the powerhouse shall be made of Polycarbonate sheet of M/s BAYER fixed to structural framework as per approved design. Arrangement shall have to be provided to prevent ingress of rainwater if any. The system shall be of M/s McCoy Architectural Systems Pvt. Ltd or similar approved.

3.01.19 Chain Link Fencing

Chain link fencing for areas as per safety requirement shall be provided. This shall be as per Civil/Structural specification.

3.01.20 **Temporary Fencing**

The construction of Temporary Fencing shall be done as mentioned below :

a) RCC post and its foundation shall be at 3.0m interval.

b) Fence shall be installed along lines shown on approved drawings.

c) Post size shall be 150sqr at bottom and 100sqr at top.

d) Total height of the posts shall be 2400mm from grade level.

e) Strainer posts shall be provided at sharp changes in grade, at comers at change of direction and where directed, and at every 30.0m interval.

f) All comer post will have two stay posts and every tenth post will have a transverse stay post.

g) Barbed wires shall run post to post and to be fixed to the posts by tightening hooks.

h) Diagonals and vertical per span with barbed wire shall be provided. In general CPWD specification is to be followed.

3.01.21 **Boundary Wall for Admin Building**

The construction of boundary wall shall be done as mentioned below:

a) RCC column and its foundation at 3 m interval.

b) RCC plinth beam with top 100 mm below ground level between RCC columns.

c) Fly Ash Brick masonry wall with cement sand mortar 1: 6.

d) 12 mm thick inside plastering with cement-sand mortar (1: 4).

e) 20 mm thick outside plastering in two layers – 12 mm internal & 6 mm external with cement – sand mortar (1: 4).

f) Minimum 100 mm thick RCC coping at top of wall with 75 mm projection on both side of wall.

g) The height of the boundary wall (at top of coping) shall be 0.75 m above the ground level. The top of RCC column shall be 150 mm above the top of boundary wall.

h) Over the boundary wall there shall be 1.25m high ornamental fencing made of wrought iron or MS Bars & Flats, with support posts & pillars having same ornamentation. The posts are to be fixed to the boundary wall with proper grout inside grouting hole of size 75x75x150mm and pillars are to be welded or bolted to cap plate fixed to the RCC columns.

i) The boundary wall shall be painted with one coat of approved primer and two coats of cement-base painting of approved manufacturer. Metallic portion shall be painted with Epoxy or PU Paint over coats of approved primer.

j) 10m on both side of the Main Gate of Admin Building complex, boundary wall shall be specially treated, aesthetically inviting with proper landscaping.

3.01.22 **Plant Main Gate and Material Gate**

a) Gate complex shall have separate vehicular entry & exit gates and also separate pedestrian entry & exit gates.

b) Vehicular entry & exit gates shall be both electrically and mechanically operated retractable gate of reputed manufacturer like DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.

c) Gate complex building shall house observation post for security personnel, frisking area with toilet facility, baggage scan area and locker facility, gate pass issuing counter, security officer room, staff office, pantry, toilets, etc.

d) Gate complex shall have inviting and landmark quality expressed through modern material and innovative idea.

e) Provision of card punching area may be kept as per discretion of the owner.

f) Construction of Material Gate shall be as follows:

g) The Gate frame shall be made of medium duty MS sections conforming to relevant IS with welded joints.

h) The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primmer and two coats of synthetic enamel paint.

i) Gates shall be fitted with approved quality iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of pad lock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

j) Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position.

k) Gates shall be installed in locations shown on drawings. Next to the main gate, a human access gate (1.25 m wide, single leaf) shall also be provided.

l) Bottom of gates shall be set approximately 40mm above ground surface and necessary guiding mechanism shall be fitted.

3.01.23 **Watch Towers**

a) Watch Towers shall be steel structure having watch platform at (+)7.0m level, 2m x 2m clear space for security staff and 1m wide watch balcony around the room or as per National security standards and as per site requirement and land terrain.

b) Steel stair shall be provided to access the platform.

c) Security room shall be brick clad/ sheeting/ Aero com panelling with full length vision window on every side.

d) Minimum roof height shall be 2.2m at edges of the balcony.

e) Roof may be of RCC or insulated metal sheet roofing.

f) Distance between watch towers shall be about 300m and at every corner or turn of the boundary wall one watch tower is to be provided.

g) Hollow metal pressed steel doors shall be used.

h) Windows shall be Aluminium/steel windows with 4mm thick clear float glass.

i) External wall surface shall be painted with Cement Paint over 20mm thick external plaster. Internal wall surface shall be painted with Oil bound Distemper over 12mm thick internal plaster. Internal ceiling surface (if RCC roof) shall be painted with Oil bound Distemper over 6mm thick ceiling plaster.

j) All steel work shall be painted with Epoxy paint over approved primer.

k) Balcony railing height shall be 1200mm.

3.01.24 **Sanitary Drainage System**

a) Diameter of Soil Pipe and Waster Pipe shall not be less than 100 mm.

b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995) or Cast Iron pipes as per IS: 1537 & IS: 3486 within the building.

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) Each floor drain should have 'P' or 'S' trap connection as required.

f) Pipe to pipe should be connected in 45^0 or 135^0 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) CI pipes shall be joined by lead caulking and UPVC pipes shall be joined by thermoplastic joint as per manufacturer's detail.

k) Soil & Waste pipes shall be taken out of the building separately and shall be connected to separate Inspection chambers. From inspection chamber further connection shall be made to either septic tank or STP line as per plant drainage scheme.

4.00.00 INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING (Refer Attachment)

4.01.00 Architectural Specification of Control Room & Annexure Room

The control room of the Turbine Building is located at Operating Floor level. It is the nerve centre of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience. To accentuate the Front portion of the UCB control room façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used.

The room will be fully air-conditioned and have access from T G hall side through Air locks to reduce the noise level as well as heat load. Each Air-lock space shall have two numbers of double leaf glazed sensor operated sliding aluminium doors. The wall facing the turbine hall shall be fully glazed aluminium partition wall with hermetically sealed insulating glass panels. Control room shall have an internal acoustic partition wall along the entire length of the room, facing operating desks. This partition shall be integrated with Digital Display Boards at different locations and have monolithic fabric finishes with high acoustical properties. It will have fully vitrified tiled floor, linear metal ceiling with A.C and lighting fixtures and wall with acrylic emulsion paint. The control room shall have very high quality furniture of approved make similar to Godrej/ Featherlight. The control desk of laminated and moulded finish of approved colour and texture, appropriate to accommodate/ house control panels, monitors shall be equipped with all functional requirements. Operator's chairs shall be swivel type on casters and have cushioned seat and back of approved material and colour. Necessary arrangement for sealing expansion joints on floor, wall and ceiling has to be ensured. Brief technical specifications of different items to be used for the control room are as follows.

a) Flooring : Non-skid, full body vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles of 1st quality dual charged similar to MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd of minimum size minimum 600 mm x 600 mm x 10mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles, under bed.

b) Skirting : Walls of UCB control room from floor level upto false ceiling level shall be provided with vitrified tiles of 1st quality, full body vitrified, 10 mm thick nonporous, homogenous, abrasion resistant cover base of matching colour, internal and external corner strip similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd and fixed to the wall strictly as per manufacturer's specification.

c) Wall finish : Columns, bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern upto the false ceiling level. The colour and design composition of ACP cladding or composite panelling is to be submitted for approval of the authority before taking up the work.

d) False ceiling : The bottom level of false ceiling shall be kept 3500mm above floor level and as applicable. Gypsum plaster board false ceiling of approved pattern having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience in order to enhance the aesthetic appearance of the control room. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. Under-deck insulation with 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining shall be provide on the ceiling, on the walls and beams above false ceiling level.

e) Air lock doors : Double acting glazed aluminium door with minimum 15 micron colour anodized finish with 3mm thick shall be used having glazing thickness 6mm of clear float glass of approved brand .The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal system.

f) The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal system.

g) Glazed partition wall : The glazed partition wall shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling. Insulating glass shall consist of 2 nos. 8 mm thick toughened plain glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. The aluminium sections shall be similar to HYDRO-Domal system.

h) Internal partition wall of control room : The internal partition wall along the entire length of the room, facing operating desk shall consist of Digital Display Boards at different locations, integrated with wall panels of Anutone Acoustic Ltd or equivalent laid flush with the display board and two nos. of matching doors on either sides for access to the rear side for maintenance. This special purpose partition shall be as manufactured by Anutone Acoustic Ltd or equivalent and

shall have rigid frame work consisting of G.I. Studs of adequate size @ 600 mm c/c and floor, ceiling and intermediate channels to provide a strong wall system capable of supporting wall hung C.C.T.V. at designated locations. The framing system shall be integrated with independent floor supported structural framework of digital display board so as to cover the entire exposed surface around the board with partition panels.

The front side of the frame shall have Excelsior Acoustical Panels – Elega finish – 2400/1200 x 600 x 19 mm thick FABRICO SoundSoak – Plane Texture of approved colour. The rear side of partition shall have Excelsior Acoustical Panels – Elega finish – especially Sound Smart – Burl of size 2400/1200 x 600 x 19 mm thick smooth finished with gypsum plaster and finished with acrylic emulsion paint. The entire wall shall have Class I fire rating as per BS code. The partition shall not transmit any load to false ceiling. The entire partition wall shall have concealed framing system and have monolithic fabric finish of approved colour or composition of two different colours as per approved design to entire exposed surfaces including door panels on control room side.

5.00.00 INTERIOR FINISH SCHEDULE FOR AUXILIARY BUILDINGS
Refer attachment for Finish schedule)

6.00.00 BRIEF DESCRIPTIONS OF NON PLANT BUILDINGS

6.01.00 Brief Description of Service Building

The Service Building is a multi storied building. However the Number of stories shall depend upon the TG operating floor level. Building is located adjacent to the Power House Building as shown in the Plot Plan. Minimum space between the service building and power house building shall be kept for Approach road for Workshop floor at Zero metre in service building. An all weather covered access corridor to be provided with powerhouse building at operating floor level. Overall area per floor of the building shall be approximately 2000 Sqm. However the building size shall be suitably decided during detail engineering stage. It will house the facilities as listed below. Building shall have 2(two) nos. Passenger elevator (13 passenger) and 1 (one) main staircases and 1 (one) fire escape staircase. Overhead water PVC / RCC tank of 10,000-litre capacity should be provided at roof of the building.

It is an important part of operation and maintenance of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience.

Facilities at Different floors shall be decided during detail engineering stage.

The Building will be centrally air-conditioned. All finishing items, Layout, and other requirements should be of owner's choice. However modern design approach of an office building like- open & flexible (workstation based) layout, usage of natural light, solar control, energy efficient, etc shall be considered. Since this is one of the most prestigious buildings, aesthetically this should achieve landmark quality.

Specially designed long and spacious RCC porch shall be given in front of the main entrance for receiving cars of VIP's.

Special attention to be given in front of service building in landscaping the area and developing garden with flowering plants and fountains etc

Shaded car parking facility with RCC roof shall be provided as per requirement of the owner.

Brief technical specifications of different items to be used for the area as follows :

a) **Flooring**

Generally floor finish shall be Non-skid double charged, fully vitrified, of Class-I quality 10/11 mm thick or as per manufacturer non-porous, homogenous, and abrasion resistant, floor tiles, of minimum size minimum 600 mm x 600 mm of approved colour & design, and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 40mm thick including the thickness of the tiles, under bed. However Workshop floor shall be provided with 50 mm thick heavy duty floor or 20 mm thick steelcrete tile floor.

For Entry cum reception lounge, VIP lounge, Main meeting/ conference room:-

Suitable and approved combination shed of marble slab and strips shall be used. Floor pattern shall be approved by the owner before erection.

For staircase and Corridors :

Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble or Baroda green and Jaishalmir yellow marble combination. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey/any other approved shade by owner.

For Toilet :

Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make, Dado shall be 100 mm higher than bottom of lintel level. Only for toilet at operating floor and Third floor, dado shall be topped with 50 mm wide matching moulded ceramic trims.

For other areas like AHU room, Generator room, Electrical room, Etc: shall have 40 mm thick heavy duty cement concrete (IPS) floor with metallic hardener and matching skirting or 20 mm thick steelcrete tile floor.

b) **Wall finish**

Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with White Cement Putty (Birla White or JK White or similar approved) for all area except areas like AHU room, Generator room, Electrical room, Etc which shall be of plastered surface with Acrylic Distemper paint. Front wall for elevator shaft shall have polished granite slab wall cladding (min 12 mm thick).

Painting to exterior surfaces of wall shall be of Acrylic Emulsion Paint similar to "Apex Ultima", "Weathergurd"/ "Weathershield" over plaster. To accentuate the building façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used.

c) **False ceiling**

It will be applicable for all areas excluding non A/C areas like AHU room, Generator room, Electrical room, Etc, pantry and toilet. It shall be of aluminium panelled (size 600x600mm) acoustic false ceiling with rock wool insulation on top similar to LUXALON of Hunter Douglas or INTERARCH having approved colour with stove enamel finish, and or Mineral fibre board of Armstrong and or Gypsum MR board as per functional requirement and interior design scheme, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.

For pantry and toilet false ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm.

d) **Doors**

Factory made Solid core wooden flush doors with high quality PVC lamination on both sides giving hi-tech expression in teak wood frame shall be used in interior office areas. The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be of similar to HYDRO- Domal system. Glazed partition may be etched with suitable and approved designed. Wooden doors shall be of factory made solid core wooden flush door with C. P. Teak veneered surfaces in wooden frame with wooden architrave.

Toilet & pantry doors shall be wooden panel door.

Doors for areas like AHU room, Generator room, Electrical room, Etc shall be hollow metal flush door.

e) **Glazed Panels**

The glazed panels shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling and maximum available width. Insulating glass shall consist of 2 nos. 6 mm thick clear float glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. The aluminium sections shall be of HYDRO-Domal system.

Glazed partition may be etched with suitable and approved designed.

f) **Windows, Glazed Curtain wall**

All windows of A/C areas shall be separated with heat reflecting glass/double insulated glass from non AC areas. Other windows shall be 15micron thick colour anodized aluminium glazed window with minimum 4mm thick clear float glass. Window system shall be of HYDRO-Domal system.

Glazed curtain wall shall be Unitised structural glazing system comprising of 30 micron colour anodised aluminium extrusions with double insulated heat reflecting glass. The system shall be able to withstand wind pressure as per relevant data given elsewhere in this specification at all heights. Structural glazing system shall be of HYDRO-Domal system or equivalent.

g) **Utilities**

All utility lines like water supply line, Electrical wiring, telephone line etc. Shall be concealed type. Fittings and fixtures for toilets should be of best quality and to be got approved by Owner prior to installation. Roof treatment, sanitary & sewerage system, roof drainage etc. Shall be as per detail technical specification.

h) Any other items of work not specifically mentioned here shall be as per the guidelines indicated in relevant Architectural Technical Specification.

6.02.00 **Brief Description of the Canteen Building**

a) This shall be single storey RCC framed structure with brick cladding. Spacing of columns shall such that large column free areas are available in the dining area.

b) The dining area shall have the arrangement to seat minimum 75 people at one time. In addition there shall be a separate executive dining area fully air-conditioned and with gypsum board false ceiling to accommodate about minimum 25 executives and separate dining area for women.

c) Adequate space shall be provided for stores, preparation, cooking, serving and washing facility.

d) Toilet and hand wash shall be kept sufficiently away from cooking area to satisfy statutory requirements.

e) Walls of the dining hall, cooking and serving area shall be given dado of glazed ceramic tiles to a height of 2100 mm.

f) Adequate exhaust fans and ventilation facility shall be given in the cooking area and in dining area.

g) Special arrangement shall be made to lead off the wastewater from canteen to the effluent treatment plant.

h) Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. Doors of other areas shall be wooden panel door, hollow metal flush door as applicable.

i) All windows shall be glazed aluminium window with diamond grill.

6.03.00 **Brief Description of the Fire Station.**

a) Fire station shall be a single/double storied RCC framed building with brick walls in office area.

b) The fire station shall have provision for parking for fire tenders including one bay for maintenance with pit, office for the station-in-charge, duty room, stores, recreation cum class room, record cum general room, toilet blocks etc.

c) Parking area for tenders shall ensure fast movement of the fire tender in an emergency.

d) In addition adequate space shall be provided for hose drying and drill ground.

e) The arrangement shall in general satisfy requirement of the local fire brigade.

6.04.00 **Brief Description of the Permanent Store.**

a) This building shall be brick clad of RCC framed structure with RCC roof or sheet metal roofing on metal deck or steel truss as per structural design consideration.

b) In the heavy material storage area, electric hoist of adequate capacity shall be provided.

c) Store building shall have facility to store heavy materials, light materials, electronic equipment & parts, etc.

d) Store building shall also provide for office space for superintendent and his supervisory staff, locker room and change room for workers, toilet etc.

e) Entry and exit of trucks shall be through adequately sized rolling shutters. In addition a minimum 2 single leaf steel flush door shall be provided for entry of the staff.

f) Adequate windows shall be provided for ventilation and lighting. Offices inside shall be of glazed partition above 900 mm high single brick wall. Total height of partition including brickwork shall be 2400 mm. Doors to the cabins shall be of glazed aluminium.

g) Gypsum board false ceiling shall be provided for AC areas.

6.05.00 **Brief Description of the Gate Complex**

a) Gate complex shall have separate vehicular entry & exit gates and also separate pedestrian entry & exit gates.

b) Vehicular entry & exit gates shall be both electrically and mechanically operated retractable gate of reputed manufacturer like DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.

c) Gate complex building shall house observation post for security personnel, frisking area with toilet facility, baggage scan area and locker facility, gate pass issuing counter, security officer room, staff office, pantry, toilets, etc.

d) Gate complex shall have inviting and landmark quality expressed through modern material and innovative idea.

e) Provision of card punching area may be kept as per discretion of the owner.

6.06.00 **Coal handling plant structures**

6.06.01 **General arrangement**

The architectural descriptions of some major structures/components covered under this package are given below :

i) **Track Hopper**

The super structure of track hopper shall have structural framing with provision for electric traction wire for electric locomotive. The roof and side sheeting shall be single skin metal cladding system comprising of profiled sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The metal cladding shall have 500 mm cover width, 47 mm high crests at 250 mm centres with special male / female side laps and anti siphoning feature to prevent leakage. 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light and louvers for ventilation purpose shall be provided for side cladding. The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided 15 % of floor area.

Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. Suitable monorails and stair shall be provided at two ends of track hopper where machine hatches are provided. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Standard G.I. hand railings on sides, as per system requirement are to be provided.

ii) **Wagon Tippler**

The super structure of wagon tippler shall have structural framing with provision of electric traction wire for electric locomotive. The roof and side sheeting shall be single skin metal cladding system comprising of profiled sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side.The metal cladding shall have 500 mm cover width, 47 mm high crests at 250 mm centres with special male / female side laps and anti siphoning feature to prevent leakage with provision of minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light and louvers for ventilation purpose. The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & also to be provided 15 % of floor area in a staggered fashion on the roof.

Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Provide continuous standard G.I. hand railings on one side covering the entire length of the hopper fulfilling requirement of railway clearance to prevent any person falling inside.

iii) **Underground Transfer Points**

All underground transfer points shall be of RCC construction with waterproofing as per specification. The intermediate floor and basement floor shall be provided with floor finish as per specification.

All underground TPs shall be provided with minimum 1.2 m wide RCC stair with hand railings as per specification. Risers for steps shall not exceed 180 mm and tread width shall not be less than 250 mm. Hand rails shall comprise of posts 40 NB M.S. galvanized pipe 1.1 m high not exceeding 1.5 m (max) c/c with 2 nos. 32 NB M.S. galvanized pipe horizontal placed at top and mid height respectively and continuous flat iron toe guard at bottom.

iv) **Over Ground Transfer Points, Pent Houses & Pump Houses**

All over ground TPs shall have R.C. foundations resting on firm strata. The super structure for TPs shall be structural steel framed with adequate bracing arrangement. All intermediate floors and roof shall be of RCC. The ground floors for buildings shall be of RCC over PCC sub base over min. 230 thick compacted boulder/stone soling. The RC floors shall be provided with floor finish as per specification and roof shall be provided with heavy water proofing treatment as per specification. The cladding shall be of brick work plastered on both faces up to 3.0 M from lowest working floor and remaining height with 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel sheet as specified above. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. Sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners. The clips shall be concealed and no fasteners are to penetrate the sheeting. Height of plinth shall be 500mm from ground level and RCC pedestals for column shall be 300mm above floor level. In all the floors steel column shall be encased with R.C.C. of min. grade M-20 with min reinforcement upto 300mm from respective floor. Adequate windows and doors shall be provided as per specification.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors with at least 20% of cladding area.

TPs shall be provided with independent steel stair block with steps of M.S. grating from ground to roof with access to roof. The width of the stair shall be minimum 1.2 m. The tread shall be minimum 250mm and riser shall be uniform throughout the height and not exceeding 180mm. Continuous hand rails shall be provided in stair. For Pent House continuous GI handrail shall be provided on roof over R.C.C. kerb. For other structures RCC parapet of 900 mm height shall be provided. The pent houses and pump houses shall be of brick cladding and treated with cement based paint as per specification. Adequate provision shall be made for roof drainage. Roof shall be

provided with 150 dia. GI rain water down comer pipes, steel door and steel windows (with Chajjas/fins) access and stair ways etc.

v) **Crusher House**

The Specification for Crusher house is similar to over ground TPs mentioned above except cladding area of Polycarbonate sheeting.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors covering at least 25% of cladding area.

The crusher house shall have an independent stair with access to roof for general use like other TPs. In addition, it shall have a separate stair block for fire escape suitably located complying with fire fighting norms of TAC. 250mm thick brick wall to be placed in suitable structural frames for stability and safety between two crushers in full height with a provision of a door.

vi) **Over Ground & On Ground Galleries & Trestles**

Over ground and on ground galleries shall be of enclosed type. The gallery shall have walkways and the width and height shall be as per system requirement. A continuous slit opening of 500 mm height shall be provided on both sides of gallery just below roof sheeting. The gallery shall be made of structural steel with galvalume sheet and minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light on roof and walls to be provided as mentioned elsewhere in this specification.

The floor for on-ground galleries shall be raised at least 500 mm above finished ground level and paved with min. 150 thick RCC (M-25) over 100 mm thick lean concrete (M10) over 230 thick boulder/stone pitching interstices filled with sand. The raised floor shall be retained by continuous brick walls at both sides of enclosures running along length of the conveyor and the surface of the wall shall be plastered and finished with cement based paints externally as per specification.

For Conveyor Galleries washing water down comer shall be provided at every Trestle location.

Roof, side sheeting and slit opening on walls for over ground conveyor galleries shall be similar to ground conveyor explained above. The area for natural light shall not be less than 15% of floor area. Crossover shall be provided at intervals not exceeding 100m c/c & stair upto the ground floor level shall be provided at every location of crossover. Crossovers shall preferably be located over four-legged rigid trestle location. Platforms for cross over shall be provided with

chequered plate flooring and hand railing as per specification. The foundations & structures for gravity take up with platform and hand railing shall be provided by the bidder's drawing and specification. Fencing with lockable gate shall be provided around Gravity take ups. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles adjacent to boiler house and railway lines shall have to be decided carefully so that there is no interference (both underground and over ground) with other buildings, equipment/equipment structures foundations nearby as well as railway lines, ducting, trenches, drains etc. Adequate clearance required by Railway authorities shall be maintained shall have. The Contractor has to execute work very carefully so that any existing foundations are not damaged. Execution and erection sequence of foundation for trestles and galleries or any other coal handling plant equipment and structures has to match erection sequence of boiler, ESP or other adjoining structures.

vii) **Substations & Control Rooms**

These shall be RCC framed structures with columns, beams, slabs and foundation etc. Cladding shall be of brick work with plaster on both side. Adequate aluminium doors and windows shall be provided for natural ventilation & views. Roof shall be provided with roof water proofing treatment as per specification. The control rooms shall have superior ambience and finish employing high quality glass, Aluminium false ceiling, dust free superior flooring etc. All air-conditioned areas (specified in Electrical Specification) shall be provided with the suspended permanently anodised aluminium natural colour matt finish false ceiling system with corrosion resistance aluminium alloy panels of minimum thickness 0.5 mm. 50mm thick mineral wool insulation (as per IS:8183) bound in polythene bags shall be laid on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, AC ducts etc. Suitable M.S. channel (min. MC 75) grid shall be provided above the false ceiling level for movement of personals to facilitate maintenance of lighting fixtures. Under deck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned areas depending upon the functional requirements.

Control panel room for control room near track hopper shall be provided with thick wired glass (min. 5.5 mm thick) on all sides so as to permit operators to have full view on operation of Track Hopper. Adequate number of 150 mm dia. RWDC pipe has to be provided. Control room floor shall be Heavy duty vitrified Ceramic Tiles tiled finish. Well polished Kota stone shall be provided for staircase, passages, lobbies and general circulation areas. 40 mm thick IPS (28 mm under bed & 12 mm thick topping with metallic hardener) shall be provided for MCC rooms, cable vault/cable spreader rooms etc. For battery room & areas of corrosive liquids, 20 mm thick acid & alkali resistant tiles set in with acid & alkali proof epoxy mortar underbed

shall be used. Silica based epoxy mortar which is chemical resistant shall be used in dado at least up to 1.5 m from finished floor level. The ceiling, door and windows and all other fixtures shall be provided with acid resisting paint as per specification.

Separate Fire escape stair shall be provided in Control Building.

All control room shall be provided with toilet facilities with toilet fixtures as specified elsewhere for 20 (twenty) users and drinking water supply facilities. All doors of toilet shall be of standard PVC door of approved make & colour. If the effluent for sewer should have independent septic tank then the septic tank shall be located at a distance of 15m (min.) from building.

viii) **Crusher House Control & MCC Room**

These shall be RCC framed structures with columns, beams, slabs and foundation etc. Cladding shall be of brick work with plaster on both sides. Adequate aluminium doors and windows shall be provided for natural ventilation & views. Roof shall be provided with roof water proofing treatment. All air-conditioned areas shall be provided with the suspended permanently anodised aluminium natural colour matt finish false ceiling system with corrosion resistance aluminium alloy panels of minimum thickness 0.5mm. 50mm thick mineral wool insulation (as per IS: 8183) bound in polythene bags shall be laid on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, AC ducts etc. Suitable M.S. channel (min. MC 75) grid shall be provided above the false ceiling level for movement of personals to facilitate maintenance of lighting fixtures. Under deck or over deck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab for air-conditioned areas depending upon the functional requirements.

Control panel room for control room shall be provided with thick wired glass (min. 6.0 mm thick) on all sides so as to permit operators to have full view on operation. Adequate number of 150mm dia. GI RWDC pipe shall be provided. Control room floor shall be Heavy duty vitrified Ceramic Tiles tiled finish. Well polished Kota stone shall be provided for staircase, passages, lobbies and general circulation areas. Overall 50mm thick IPS (27mm underbed & 13mm thick topping) shall be provided for MCC rooms, cable vault/cable spreader rooms etc. For battery room & areas of corrosive liquids, 20 mm thick acid & alkali resistant tiles set in with acid & alkali proof epoxy mortar underbed shall be used. Silica based epoxy mortar which is chemical resistant shall be used in dado at least up to 1.5 m from finished floor level. The ceiling, door and windows and all other fixtures shall be provided with acid resisting paint as per specification.

Separate Fire escape stair shall be provided in Control Building.

All control rooms shall be provided with toilet facilities and drinking water supply facilities. All doors of toilet shall be of standard PVC door of approved make & colour.

6.07.00 **Interior Finish Schedule For Non Plant Buildings (Refer attachment for finish schedule)**

7.00.00 **DESIGN DATA FOR ARCHITECTURAL WORKS**

1	Brick works – internal and external	:	230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.
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 manu-facturer'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	:	6 mm thick with 1:3 cement-sand mortar
6.	White Cement Putty Punning	:	2 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

7. Cladding for Power house

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. Zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side.

The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti- siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub-girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) 'Z' shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool Insulation of density 48KG/M3 conforming to IS: 8183 shall be provided and fixed to the inner sheet and between the two sheets as per specification. If the insulation is made of polyurethane foam then the core in between the outer profiled sheet and the inner sheet will be formed out of polyurethane foam in 30mm thickness having a density of 40-45 kg/cum. The foam shall be in filled in between the outer and the inner sheet using a highly dedicated foaming machine and the entire process of forming the panel will be carried out at factory Panels may be prefabricated factory made panels or in-situ type. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Approved Manufacturer : LLOYD Insulations (India) Ltd. TATA Blue Scope Steel, or similar approved.

8. False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system.

   Approved make : LUXALON by Hunter Dauglas, LLOYD, Armstrong, INTERARCH or similar approved.

   In other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used.

   Approved make : Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX, Aerolite or similar approved.

9. Floor finish

a) Generally finish to utility areas shall be 40 mm thick heavy-duty patent stone 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 equal or similar to BASF's MASTERTOP 230i. 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 equal or similar to MASTERKURE 181, 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.

   Approved make : BASF, Ironite or similar

b) For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows :

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be 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. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. 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.

c) For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali 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.

Approved Make	:	ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. Or similar approved.
Paints	:	ICI, ASIAN Paints, Berger or similar approved.

d) For battery room finished with Epoxy Flooring (where required)

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components,

Comp A and B : 1:2.5 by weight

Over the primed surface, epoxy modified cementitious self □levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A :Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30ºC approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components,only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 27^0 C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF or similar.

e) All areas of toilet, including W.C and urinal shall have 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.

Approved Make : Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved.

f) Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate - PVC/ Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of □evelling and accurately align panels for a maximum ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement. The Pedestal head assembly shall consist of a 90 x 90 mm x 4.00 mm embossed head mechanically riveted to a 100mm long 20mm Dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 25.00 mm OD pipe of thickness 2.00 mm mechanically locked on a press for perpendicularity and then welded to a base plate of 125 x 125 x 2.50 mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, and rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x570 mm length.

Approved make of Til e: Unitile® USF 1500 or similar approved.

g) Floor/staircase and the areas prone to slippage due to oil spillage etc. Shall be provided with non-skid floor finish.

h) 750 mm wide, minimum, R.C. paving as plinth protection, shall be provided around all buildings with surface drain of required size.

i) Risers and treads of concrete staircase of powerhouse shall be of white marble slab and in all other stairs; same shall be of Kota stone finish. 20/25 mm thick Kota stone finish excepting main stair riser and treads shall be of marble. All areas shall have 150 mm high skirting unless indicated otherwise in the specification.

j) For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.

10. Doors and Windows

a) Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.

Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames should be Mitered and field assembled with self tabs. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf should be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass should be 5 mm clear toughened glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware.

Approved make	:	Shakti Met Dor, NCLSeccolor, Godrej, Gandhi Automation Pvt Ltd, or similar.
Approved Harrware	:	DORMA, Guardian

b) Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel confirming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

Approved Make	:	Shakti Met Dor, Godrej, Navair, Promat, Gandhi Entrance Automation Pvt Ltd, or equivalent.
Hardware list	:	Hinge, Door closer, Panic Bar with external trim, Mortise lock & latch with lever handle for without panic bar door.
Approved Hardware	:	DORMA, Guardian

c) Main Entrance of Control Room, Control Equipment Room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing with sensor operated sliding type for main entrance for main control room, service building, administrative building and double swing type for control equipment room, etc.. Doors of control room, control equipment room, computer room, etc. Shall be full glazed pre-coated minimum 3mm thick aluminium i.e. coloured anodized aluminium. Full glazed aluminium partition with airlock shall be provided along (B) row of Turbine hall operating floor where clear view is desired. Glazing between air-conditioned areas shall be single glass whereas that between air- conditioned and non-air- conditioned area shall be with hermetically sealed insulating glass.

Approved Make	:	Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved. al Systems of HYDRO, Hidalco, DORMA, or equivalent.

d) Doors of W.C. and shower shall be wooden panel door.

e) All windows and ventilators for prestigious buildings like power house, service building canteen, fire station, administrative building etc. Shall be glazed aluminium windows conforming to IS:1949 & IS: 1948.

Approved Make	:	Domal Systems of HYDRO, Hindalco, DORMA or equivalent.

f) Pre-coated (polyester painted) steel windows and ventilators may be used for auxiliary plant buildings.

Approved make : Ncl Altek & Seccolor Ltd.

g) Alternatively steel reinforced UPVC windows may be used for some non plant building if agreed by the owner.

Approved make : "Fenesta" by DSC Ltd.

Approved Hardware for doors shall be of HAFELE, DORMA or similar approved.

11. Rolling Shutters : Rolling shutters as per IS: 6248 with suitable operating arrangement (manual, mechanical and/or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. 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.

Approved Make : DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.

12. **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 6.0 mm thick toughened float glass as specified below shall be provided in doors, partitions, windows of Power house building, Service Building, Administrative Building, etc.

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 15 micron coloured anodised aluminium frame suitable for structural glazing system. Quality of glass is given below.

e) 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.

f) 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.

Approved make : AIS of Asahi India Glass Ltd., Pilkington Glass India Pvt. Ltd. Saint Gobain or approved equivalent.

13. **Roof waterproofing**

a) Roof water proofing treatment shall be as follows :

i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be, a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR of BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC

requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

iii) For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

h) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.

i) APP membrane shall conform to Conforms to: UEAtc, ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.

j) Technical Data

- Chemical Base APP modified Bituminous Polyester
- Thickness 4mm
- Unit weight 4.40 kg/m2(According to UEAtc)

k) Mechanical / Physical Properties

- Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
- Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
- Resistance to water pressure - No leakage - (According to DIN52123)
- Carrier (Polyster) weight- 180 g/m2
- Softening Point - 145 oC - (According to ASTM D36)
- Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
- Tear resistance (L/T) N-170/180- -(According to UEATc)
- Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
- Heat Resistance- No Flow at 100oC-
- Resistance to Aging after 2000 hrs (Weather –O-Meter)- No Delamination- (According to ASTM D4799)

l) Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.

m) Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.

n) All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

Approved make of elastomeric membrane: SIKA India Pvt. Ltd, LLOYD, STP Ltd., BASF, Dr. Fixit or similar approved.

Approved make of APP Bitumen membrane: SIKA or similar approved.

Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.

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) The contractor shall give guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for twenty (20) years. The mode of execution of the guarantee shall have to be acceptable to the owner.

d) Heavy duty HDPE pipes 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.

14. **Painting**

a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint similar to "Apex Ultima", "Weathergurd" / "Weathershield" over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.

b) Acrylic plastic emulsion paint of AkzoNobel/Asian Paints/ Berger or any other reputed make approved by TSGENCO shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.

c) All other areas shall be provided with Acrylic Distemper paint.

d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade up to a height of 1.5 m above floor level.

e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with acid/alkali resistant paint. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Acid & Alkali resistant paint.

f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, non toxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

g) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.

h) All fire exits shall be painted in Post Office red.

i) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

j) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

k) Paints shall be of reputed brand of reputed manufacturer like AkzoNobel/Berger/Asian Paints, Nerolac. For granular textured coating Vineratex, Heritage or equivalent shall be used.

15. Aluminium Composite Panels

1. Material:

   Total thickness of the panel – 4mmThickness of the aluminium skin – 0.5mm, Tensile strength of aluminium skin –120N/mm2 minimum, Density of PE core – 920 – 980 Kg/m3 (Non toxic grade Polyethylene) Coating – PVDF Adhesive film – DUPONT, USA Coating thickness (front foil) – 24µ - 30µ in PVDF including primer.15µ - 18µ in polyester coating. Coating thickness (back foil) – 4µ - 7µ polyester coating.

2. Colour – as indicated in the drawing.

3. Fixing arrangement – aluminium composite sheets shall be folded inwardly on four edges (without cutting the outer skin) to from Aluminium Composite Panels (ACP) and shall be riveted to the aluminium extruded section like angel or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be200mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant of approved make (GE or similar make) to prevent water seepage.

4. The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The contractor shall take site measurement and produce working drawings for approval of engineer before erection of ACP.

5. Name of system provider- Eurobond, Alu Bond, or similar.

16. Poly Carbonate Sheet:

1. 4mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or similar approved.

2. Framing shall be specially designed aluminium sections, colour anodised, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.

3. Sealing of joints shall be done with Silicon sealant.

   Approved make : BAYER India, GE or similar

a) Shape of the roofing shall be as per drawing and approved by the owner.

b) Name of system provider – McCoy Architectural Systems Pvt. Ltd. / Citadel Architectural Solutions Pvt. Ltd. / or equivalent.

c) System provider shall prepare and submit the detailed working drawing for approval of engineer before erection.

17. **Stairs**

a) All stairs shall have not more than 13 risers in one flight but in case of fire escape stairs, 15 risers may be allowed instead of 13 risers. Height of risers and width of treads shall be180 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 166mm (maximum) & 250mm (minimum) for general staircases. Minimum width of stairs shall be1000mm for fire escape stairs and 1200 mm for general stairs. In general rises shall be 150 mm.

b) Aluminium angle nosing shall be provided for edge protection of RCC stairs. Moulded marble nosing shall be provided for the main stairs finished with marble slab / Kota slab finishes.

c) 40ø NB stainless steel pipe handrail for stair in T.G. Hall area and 32ø NB medium class G.I pipe Handrail for stairs in other areas, minimum1.0 metre high, shall be provided around all floor/roof openings, projections/balconies, walkways platforms, concrete and steel stairs.1200mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000mm / 1200mm above the walkway/ platform/ floor surface and the intermediate rail 500mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500mm c/c to posts. Stainless steel class shall be 304 grades.

18. Draining out water from floors

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc. Shall be provided in each floor.

19. **Fencing**

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, trans-former yard, building transformer area, fuel oil area, Dry ash storage silo area & other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high PVC quoted galvanized chain link fencing of minimum 8 gauges (including PVC coating) of mesh size 75 mm and galvanized concertina for switch yard/transformer yard. Galvanized barbed wires of a height of 0.6 metres shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level.

20. **Water Supply and Sanitation**

a) RCC 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.

c) Extra heavy cast iron pipes with lead joints or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.

d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.

e) Each 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 in each floor.

- Water closet – Indian & European type.
- Large flat back urinal with porcelain divider.
- Shower set.
- Wash basin – Counter-top wash basin to be provided in office areas selectively as per Owner's desire.
- Sink – Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas of "FRANKE" or similar approved make.

- Metal storage cabinets, under- counter as well as overhead, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
- Minimum 600 mm long porcelain tray.
- Minimum 500 mm long stainless steel towel rail.
- Stainless steel liquid soap holder.
- Recessed porcelain soap tray in shower area.
- Stainless steel toilet paper roll holder.
- Robe hooks
- 450x750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor.
- Septic tanks with up-flow filter including all accessories and extra heavy cast iron soil lines shall be provided.
- Effluent from septic tank shall pass through chlorination chamber to bring down BOD level to acceptable limit before discharging to nearest drain or to STP Main line.
- 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.

Note Toilets in Power House Operating Floor, Operating floor of service shall have coloured fixtures including counter-top wash basins with wide mirror, European type water closet with flush valve, sensor operated urinal, exclusive shower set etc. Other toilets in general shall have white porcelain fixtures, low down cisterns, sensor operated urinals etc. Toilets for handicapped persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

Approved Make of toilet fixtures	:	KOHLER, Hindware, Parryware, Nycer, Cera.
Approved make of toilet fittings	:	KOHLER, Jaquar, ESCO, ESS ESS,.

21. **Under-Deck & Over-Deck Insulation**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- Density of Material shall be between 40 to 60 Kg/m3
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C
- 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
- Material should be FM (Factory Mutual), USA approved.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48×10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

  Under-deck Insulation thickness shall be minimum 26mm for Kizen Project. Under-deck insulation shall be provided for all AC areas having roof exposed to sun.

Approved manufacturer- Armaflex, Kflex

For thermal over-deck insulation on the terrace BASF's PERIPOR board or similar shall be used. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

Colour: Orange

Thickness: 50 mm

Compressive strength: 200-220 kN/m2

Thermal Conductivity (K): 0.034 W/Mk

Thermal Transmittance (U): 0.5-0.6 W/m2 oC

Water Absorption (% vol): <0.1% (by total immersion)

Actual area covered would be used for measurement.

22. **Sealant**

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation equal or similar to MASTERFLEX 700i of BASF 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 shall be similar or equal to Masterflex 472/474 of BASF. 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%.

3. Bitumen sealing compound shall be conformed to IS:1834. Preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.

23. Approved make of other items

a)	Expansion Joint Control	3R Construction Solutions Pvt Ltd or similar
b)	Silicon Sealant	Dow Corning India Pvt. Ltd, McCoy Silicones Ltd. Or similar
c)	Insulation	TWIGA-for glass wool insulation, LLOYD, Mineral Rock Fibers Ltd.- for mineral fibre wool insulation. LLOYD for Rockwool insulation

		For extruded polystyrene foam insulation, "Insuboard" by The Supreme Industries Ltd BASF, TEXA or similar approved. For PU Insulation by BAYER India or similar approved.
	d) Toilet Partition:	Merino-Besco or equivalent.

24. **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), 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.

ANNEXURE - III
DESCRIPTION OF NON-PLANT BUILDINGS

Interior Finish Schedule For Non Plant Buildings

	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
1.	Service building						
	a) Entry cum reception lounge, VIP lounge, Main meeting/ conference room	Suitable and approved combination shed of marble slab and strips shall be used	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Aluminium panelled (600x600mm size)acoustic false ceiling with glass wool insulation on top similar to LUXALON of Hunter Douglas or "INTERARCH" having approved colour with stove enamel finish, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.	Sensor operated Aluminium glazed sliding door at main entry Collapsible door shall also be provided.	Aluminium glazed window At ground floor Aluminimum diamond I Grill @ 20 Kg/sq.m shall be provided	
	b) Other floors/ office area etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" , "Kajaria" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with matching shirting of same make	- Do -	Gypsum board or Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Aluminium glazed door/Pressed steel hallow metal door/ Fire door	Aluminium glazed window	
	c) For staircase and Corridors	Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey shed or colour as approved by the owner.	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Acrylic Distemper paint colour super white.	-Do-	-Do-	

Interior Finish Schedule For Non Plant Buildings

	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	d) Toilet & pantry	Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado shall be 100 mm higher than lintel level starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	False ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm	"Main entry to toilet or wet areas shall be wooden panel door in hard teak wood frame and doors for WCs shall be UPVC door frame & shutter."	-Do-	
	e) AHU room, store Generator room, Electrical room, Etc:	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door	-Do-	
2.	Canteen Building						
	a) Kitchen, Dining hall etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counter for Kitchen and service areas shall have Polished Granite slab over RCC slab or Kadapa stone	1st quality coloured glazed tiles of minimum 6/7 mm thickness up to 1.20mts height and balance height with Acrylic emulsion paint over primer and white cement putty	Acrylic Distemper paint over white cement putty. Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Aluminium glazed door	Aluminium glazed window	
	b) Other areas	Kota stone flooring and skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Solid core flush door	Aluminium glazed window / ventilator	

Interior Finish Schedule For Non Plant Buildings

	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	c) Toilet & wash areas	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 400 mm x 400 mm over IPS floor (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be PVC door frame & shutter.	Aluminium glazed window / ventilator	
3.	Permanent Store & Inflammable Store Building	50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting. For office areas & AC stores vitrified tiles shall be used.	Acrylic emulsion paint with white cement putty for office & AC store areas and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height for other areas	Acrylic Distemper paint over white cement putty. Offices and Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Hollow metal flush fire door/ Aluminium glazed door. Rolling shutter wherever necessary	Aluminium glazed window / ventilator	
4.	Main Gate Complex	Overall 40 mm thick Kota stone slab flooring	Acrylic emulsion paint over white cement putty	Acrylic emulsion paint over white cement putty	Hollow metal flush fire door/ Aluminium glazed door	Aluminium glazed window / ventilator	
5.	Weigh Bridge Control room	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door/ Aluminium glazed door	Aluminium glazed window / ventilator with MS grill	

Interior Finish Schedule For Non Plant Buildings

	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
6.	Workshop Area & Bull dozer maintenance building						
	a) Workshop area, Bulldozer shed area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door & Rolling shutter wherever necessary	Steel glazed window / ventilator	
	b) stores	-Do-	-Do-	-Do-	-Do-	-Do-	
	c) offices	10 /11mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for offices.	Acrylic emulsion paint over white cement putty	Moisture resistant Gyp Board or Calcium silicate Board false ceiling with insulation on top.	Aluminium glazed door	Aluminiuml glazed window	
	d) Laboratory	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile.	Acid / Alkali resistant paint in acid & alkali prone area.	Acid / Alkali resistant paint in acid & alkali prone area.	Aluminium glazed door	Aluminiuml glazed window	
	e) toilet	Overall 50mm thick Kota stone finish with 25mm thick Kota stone slab and 5 mm thick glazed ceramic tile dado of approved make. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	Acrylic Distemper Paint	Acrylic Distemper Paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be PVC door frame & shutter.	-Do-	

Interior Finish Schedule For Non Plant Buildings

	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
7.	Fire Station						
	a) Office area, Toilet, Stores, Training room, Kitchen / Dining area, Dormitory,	"10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High."	Acrylic emulsion pain	Acrylic emulsion paint	Aluminium glazed door/ hollow metal flush door	Aluminiuml glazed window	
	b) Fire tender parking area and equipment store	50mm thick heavy duty IPS flooring with metallic hardener with matching skirting. or Paving with 65/70 mm thick pressed interlocking precast blocks	Cement paint and for equipment store Acrylic Distemper all be used	Parking area cement paint and for equipment store Acrylic Distemper shall be used.	Aluminium glazed door/ hollow metal flush door for equipment store	Aluminiuml glazed window for equipment store.	
8.	Watch Tower	IPS flooring with Cement Skirting	Acrylic Distemper, Epoxy paint over exposed steel structure.	Acrylic Distemper, Epoxy paint over exposed steel structure.	Hollow metal flush fire door	Steel glazed window / ventilator	
9.	Car & Scooter parking shed and Cycle parking shed	Mimimum 50mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over PCC underbed. Parking near Administrative block shall have vitrified tiles suitable for parking of brand Endura of HR Jonson or similar approved.		Polycarbonate roof sheeting over RCC framed structure.			

VOLUME : VII-C

SECTION-III

TECHNICAL SPECIFICATION FOR AREA GRADING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	VII-C/S-3 : 1
2.0.0	GENERAL	VII-C/S-3 : 1
3.0.0	EXECUTION	VII-C/S-3 : 3
4.0.0	TESTING AND ACCEPTANCE CRITERIA	VII-C/S-3 :15
5.0.0	NFORMATION TO BE SUBMITTED	VII-C/S-3 :15
6.0.0	RATES	VII-C/S-3 :16
7.0.0	MEASUREMENT	VII-C/S-3 :17

VOLUME : VII-C

SECTION-III

TECHNICAL SPECIFICATION FOR AREA GRADING

1.0.0 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 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 subgrade, placing and compacting soils in fills, pumping to keep excavated areas dry, final grading of designated areas, disposing off unsuitable and excess excavated materials and incidentals thereof.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

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

a) Furnish all labour, supervision, services, earth-moving machineries 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.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.2.0 **Work to be provided for by others**

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

However, the Owner reserves the right to award the whole work to one Contractor or to split up the work for awarding to two or more Contractors.

2.3.0 **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 : 3764	:	Indian Standard for Safety Code for Excavation Work.
IS : 1200	:	Indian Standard Method of Measurement of Building (Part-I)and Civil Engineering Work Part-I - Earthwork.
IS : 4701	:	Indian Standard Code of Practice for Earthwork on Canals.
IS : 4081	:	Safety Code for Blasting and Related Drilling Operations.

2.4.0 **Conformity with Designs**

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

2.5.0 **Materials to be used**

2.5.1 **General**

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

2.5.2 **Borrow Material**

Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material.

2.6.0 **Quality Control**

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

a) Lines, Levels and Grades :

i) Periodic Surveys

ii) Establishment of markers, Boards etc.

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.

2.7.0 **Information regarding Site Conditions**

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

3.0.0 EXECUTION

3.1.0 Setting Out

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor at his own cost.

3.2.0 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

3.3.0 Clearing and Grubbing etc.

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush vegetation, rubbish, slush, etc. and levelled up. Trees upto 300 mm girth shall be uprooted. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot- holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.4.0 **Classification**

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

a) **Ordinary and hard soil**

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

b) **Soft and Decomposed Rock**

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

Excavation in macadam and tarred roads and pathways, brick work etc. shall be considered at the same rate as excavation of this type of soil.

c) **Hard Rock**

This shall include rocks occuring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be measured under this item, unless a separate provision is made in the schedule of Quantities for the same.

3.5.0 Earthwork in Excavation

3.5.1 General

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

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

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

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted to 95% of modified Proctor Density or as directed by the Engineer.

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

On completion, the work will be finally checked and approved by the Engineer. In cases where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.5.2 Excavation in Hard Rock

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

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

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

3.5.3 Blasting

3.5.3.1 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencent of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting licence from the authorities concerned.

Contractor shall obtain necessary licence for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such licence, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies/ regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiselling prior to the blasting operation seperating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 100. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superceeded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.5.3.2 **Storage of Explosive**

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detowators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

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

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any duststorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.3.3 **Carriage of Explosives**

Dctonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.3.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

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

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encirled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shotfirer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

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

3.5.4 **Disposal**

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

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) By either spreading
or
ii) Spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back-filling or other purposes by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.5.5 **Dewatering**

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area without any extra cost. Method of dewatering shall be got approved by the Engineer.

3.6.0 **Treatment of Slips**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and backfilled later by him at his own expenses.

3.7.0 **Earthwork in Filling**

3.7.1 The material to be used for area filling shall be selected material, approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

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

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 150 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Each layer shall be watered and properly compacted to 95% of modified Proctor Density unless otherwise permitted/directed by the Engineer. Earth shall be compacted with approved machine and usually manual compaction shall not be allowed unless specifically permitted by the Engineer.

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

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

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

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms. approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.7.2 **Filling in Disposal Areas**

Excavated materials if not used in area filling, will be disposed off in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer. All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer. No payment for compaction shall be made for such nominal compaction.

3.8.0 **Approaches and Fencing**

The Contractor shall provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the area shall 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, if directed by the Engineer.

3.9.0 **Lighting**

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. Even if no night work is in progress, red warning lights should be provided at the top in edges of the excavated area and the edges of the fill, unless otherwise permitted by the Engineer.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.

The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth, at the Contractor's cost.

Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.0 Area-filling

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

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender :

I) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.

iii) Method of transportation.

5.2.0 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption :

a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area- filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits,if any, fencing etc. for approval of the Engineer for adoption.

6.0.0 RATES

6.1.0 Excavation and Disposal

The rates of earthwork for all types of soils, soft and decomposed rock and hard rock and leads as listed in the Schedule of Items will include the cost of all materials consumed, hire charges of tools and plants and equipment, cost of labour, insurance, taxes and royalties, security and safety arrangements, power, fuel, lubricants, services, accommodations, supervisions, overheads, profits etc.

The rates of excavation should also include the cost of dewatering. The Contractor will have to give a rebate for non-compaction in case the excavated material is stacked for use in back-fill by some other agency at a later date or dumped and spread in the disposal area with nominal compaction.

6.2.0 Area-Filling by Excavated Earth and Compaction

The rates to be quoted for this item should be complete in all respects including transporting earth available from excavation under Cl. 6.1.0 and include all the components of cost listed under Cl. 6.1.0. No extra will be payable for filling at any depth.

6.3.0 **Area-Filling by Earth brought from Borrow Pits or Stacks left by other Agencies**

In case sufficient earth of proper quality is not available from the excavated spoils, the Engineer may direct area filling to be done by bringing earth from borrow pits or selectively from stacks left by other agencies. The material in the stacks which are considered by the Engineer to be unfit for use in the fill, shall be carted away by the Contractor to the disposal area.

The rate to be quoted against the relevant item of the schedule should be complete in all respects and include all the components of cost listed under Cl.No. 6.1.0 of this specification. No extra will be payable for filling at any depth. Leads will however be paid as per Schedule of Items.

6.4.0 **Dewatering**

The rate for any dewatering of the area during the period of contract, original or extended, shall be deemed to have been included in the unit rate of excavation.

7.0.0 **MEASUREMENT**

7.1.0 **Clearing and Grubbing**

No separate measurement shall be done for this item for the purpose of payment in general, except for cutting of trees, having girth more than 300 mm.

7.2.0 **Excavation and Disposal**

Actual quantity of excavation required and approved by the Engineer shall be measured in Cu.M. No extra shall be paid for keeping the excavations dewatered as required. Necessary disposal of the spoil for filling or stacking as described in the Schedule of Items shall be included in the quoted rate.

The measurement may be done by direct tape measurement or by cross sections derived from initial and final levels.

7.3.0 **Area Filling with Earth from Stacks**

Actual quantity of filling as worked out from the contour drawings or the volume of the stack with a deduction of 30% (thirty percent) for compensating the voids shall be measured in Cu.M. The measurements will be taken before any monsoon passes over the area.

7.4.0 **Area-Filling with Earth from Borrow Pits and Stacks**

Actual quantity of excavation in the Borrow pits, or the volume of the stack with a deduction of 30% percent for voids, in case filling is done from stacks, shall be measured in Cu.M. The lead as mentioned in the Schedule of Items shall be included in the rates quoted.

VOLUME : VII-C

SECTION-IV

TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	VII-C/S-4 : 1
2.0.0	GENERAL	VII-C/S-4 : 1
3.0.0	EXECUTION	VII-C/S-4 : 4
4.0.0	TESTING AND ACCEPTANCE CRITERIA	VII-C/S-4 : 17
5.0.0	INFORMATION TO BE SUBMITTED	VII-C/S-4 : 18
6.0.0	RATES	VII-C/S-4 : 18
7.0.0	MEASUREMENTS	VII-C/S-4 : 19

VOLUME : VII-C

SECTION-IV

TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

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

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

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

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests Whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.2.0 **Work to be provided for by others**

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

2.3.0 **Codes and Standards**

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

IS:1200	:	Method of Measurement of Building and Civil (Part-I) Engineering work;Part-I Earthwork.
IS:2720	:	Determination of Moisture Content (Part-II)
IS:2720	:	Determination of Moisture content / Dry Relation (Part-VII) using Light Compaction.
IS:2720	:	Determination of Density Index (Relative Density) (Part-xiv) of cohesionless soils.
IS:2720	:	Determination of Dry Density , in place, by core (Part-xxix)cutter method .
IS:2720	:	Determination of Dry Density of soils, in place, xxviii) (Part-by sand replacement methods.
IS:3764	:	Safety code for Excavation work.
IS:4081	:	Blasting and Related Drilling Operations
IS:4701	:	Earthwork on canals

2.4.0 **Conformity with Designs**

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

2.5.0 **Materials to be used**

2.5.1 **General**

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

2.5.2 **Borrow Material**

Borrow material required for back-filling shall be excavated from approved locations and levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

2.6.0 **Quality Control**

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

a) Lines, Levels and Grades :

i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling :

i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction

2.7.0 **Information regarding site conditions**

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

3.0.0 EXECUTION

3.1.0 Setting Out

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross- sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made therefrom, shall be jointly signed by the authorised respresentative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing, etc.

The area to be excavated or filled shall be cleared outof fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

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

3.4.0 **Classification**

All earthwork shall be classified under the following categories :

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

a) **Ordinary Soil**

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

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) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

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

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

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

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

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

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

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

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this overcut is not due to negligence of the Contractor. The decision of the Engineer as to the admissibility of such overcut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.5.2 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

3.5.3 Excavation in Hard Rock

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

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

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

3.5.4 Blasting

3.5.4.1 General

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superceeded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.5.4.2 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

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

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any duststorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.4.3 **Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging

operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

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

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encirled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shotfirer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

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

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

3.5.5 **Disposal**

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

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or

ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavationin rock should include the cost of disposal as per (d).

3.5.6 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately and shall be measured in stacks deducting 30% volumetric measure for voids.

3.5.7 **Protection**

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

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

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.5.8 **Dealing with Surface Water**

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

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

Where works are undertaken in the monsoon period , the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.5.9 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment and measurement, provided the Contractor has completed all the work satisfactorily.

3.5.10 Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the reponsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

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

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

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

3.5.10.2 Open Timbering

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

3.6.0 Treatment of Slips

he Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.7.0 **Back-filling**

3.7.1 **General**

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

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

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

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 9o% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of Silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer.

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

3.7.3 **Plinth Filling**

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

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

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

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

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

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

3.7.5 **Filling in Disposal Area**

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

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

3.8.0 **Approaches and Fencing**

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

3.9.0 **Lighting**

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

4.0.0 **TESTING AND ACCEPTANCE CRITERIA**

4.1.0 **Excavation**

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer, at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.0 **Back-filling**

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

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.2.0 After Award

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

a) Within 30 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures. In case the Earthwork Contractor is also the agency for the foundation work, the Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

6.0.0 RATES

The rates for the items shall include cost of all materials consumed in the works, hire charges of materials, tools and plant, cost of labour, insurance, all transport, taxes, royalties, security and safety arrangements, supervision, profit etc. The rates of excavation shall also include the cost of dewatering (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) and stacking the excavatedspoils properly within a lead of 30M, unless otherwise mentioned in the Schedule of items.

The Contractor will have to give a rebate if the excavated earth is directly used for back-filling.

Where back-filling is to be done with sand, it shall be of good quality from quarries approved by the Engineer. The rate shall include all operations including the cost of sand.

In case the Contractor is required to continue dewatering of the excavated pits beyond the period of the contract, original or extended, he will be paid separately for it as per the schedule of items only for the period beyond the final terminal date of the contract. The rate will be complete in all respects including the cost of consumables, if any.

7.0.0 MEASUREMENTS

7.1.0 Clearing and Grubbing

No separate measurement shall be done for this item for the purpose of payment in general except for cutting of trees having girth more than 30 cms. and works connected to this.

7.2.0 Excavation

Actual quantity of excavation required and approved by the Engineer shall be measured in Cu.M. No extra shall be paid for keeping the excavations dewatered as required for completion of the structure to come in. Necessary disposal of the spoils as described in the schedule of items shall be included in the quoted rate.

7.3.0 Shoring

The actual effective area of shoring as approved by the Engineer, shall be measured in Sq.M. All planks, wallings, verticals, struts, props and all other materials as required for the shoring and subsequent safe dismantling and removal shall be included in the rates quoted.

7.4.0 Back-filling

7.4.1 With Assorted Earth from Excavations for Foundations, Trenches etc.

Actual quantity of consolidated backfill shall be measured in Cu.M. The cost of lead, lift, etc. shall be as per schedule of items and included in the rate quoted.

7.4.2 **With Earth from borrow pits and stacks**

Actual quantity of consolidated back-filling or actual quantity of excavation in the borrow pits, or the excavated volume of the stack with a deduction of 30% for voids, in case filling is done by earth from stack, whichever is less, shall be paid in Cu.M. The lead, lift, etc. as mentioned in the Schedule of Items shall be included in the rates quoted.

7.4.3 **Sand filling**

Actual quantity of consolidated sand filling shall be measured in Cu.M. The rate shall include cost of sand and all necessary works for execution of the items.

7.5.0 **Leads and Lifts**

The leads for excavation and/or back-filling will be measured between the centroid of the actual disposal area and that of the plan of the pit. The distance between these two points will be measured along the shortest practicable haulage path as decided by the Engineer.

Lifts will be measured vertically between the average ground level from where the pit excavation was started and the botton level of the excavated pit. Level lines corresponding to the stages where

lifts become payable will be drawn on the cross section of the pit and the volumes of excavation contained between these horizontal planes will be computed and paid according to the corresponding rates.

7.6.0 **Dewatering**

Dewatering for work beyond the Contract period original or extended will be measured on the basis of horse power - hour which will be obtained by multiplying the estimated requirement of horse power required to run the pumps or actually employed, whichever is less, by the actual hours run, approximated to the nearest half hour.

VOLUME : VII-C

SECTION-V

TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE [PLAIN & REINFORCED]

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-5 : 1
2.00.00	GENERAL	VII-C/S-5 : 1
3.00.00	INSTALLATION	VII-C/S-5 : 11
4.00.00	SAMPLING AND TESTING	VII-C/S-5 : 52
5.00.00	ACCEPTANCE CRITERIA	VII-C/S-5 : 54
6.00.00	LIST OF I.S. CODES AND STANDARDS FOR REFERENCE	VII-C/S-5 : 55

VOLUME : VII-C

SECTION-V

TECHNICAL SPECIFICATION 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 precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

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

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

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

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

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval of detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval of shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval of detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval of 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 of concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval of results of tests of various properties of the following:

   i) The various ingredients of concrete

   ii) Concrete

   iii) Embedments

   iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and Schedule of Items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 **Work by Others**

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

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 **With Tender**

The following technical information are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award**

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

a) **Programme of Execution and Requirement of Materials**

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving month-wise requirements of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

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. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) **Design Mix**

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S. Codes, is to be submitted to the Engineer for his approval before it can be used on the works.

d) **Detail Drawings and Bar Bending Schedules**

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(b) and 3.16.1 of this specification.

e) **Detailed Drawings and Designs of Formworks to be used**

Detailed design data and drawings of formworks to be used as per clause 2.1 (c).

f) **Detailed Drawings for Templates & Temporary Supports for Embedments**

As per Clause 2.1 (e).

g) **Mill Test Reports for Cement & Reinforcing Steel**

Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.

h) **Inspection Reports**

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.4 of this specification.

i) **Test Reports**

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 **Cement**

Generally the following type of cement shall be used with prior approval of the Engineer :

a) 43 Grade Ordinary Portland Cement conforming to IS: 8112

b) 53 Grade Ordinary Portland Cement conforming to IS: 12269

c) Portland Slag Cement conforming to IS: 455

d) Portland Pozzolana Cement (fly ash based, by intergrinding Portland Clinker) conforming to IS:1489 (Part-1)

e) Portland Pozzolana Cement (calcined clay based) as per IS: 1489 (Part-2)

In special cases, the following types of cement may be required to be used with prior approval by the Engineer:

a) Rapid hardening Portland Cement conforming to IS: 8041

b) Hydrophobic Cement conforming to IS: 8043

c) Low heat Portland Cement conforming to IS: 12600

d) Sulphate Resisting Portland Cement conforming to IS: 12330

N.B.: Blending of Fly Ash with Ordinary Portland Cement at site is not allowed.

2.05.03 **Aggregates**

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious materials. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) **Coarse Aggregate**

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

The grading of coarse aggregates by sieve analysis shall be as per IS: 383.

b) **Fine Aggregate**

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 will be termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand , one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS: 383. In most cases, the preferred zone is Zone - II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer.

2.05.04 **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 will be followed for routine tests. Acceptance test for water shall be as per IS: 3025, and Table - 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 will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

IS: 2645 - Integral cement water proofing compound

IS: 9103 - Indian standard specification for Admixtures for Concrete

Or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, Part 1 to 3) and may be one of the following:

a) **Accelerating admixtures**

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or approved equivalent.

b) **Retarding admixtures**

- Modified lignosulphonate based set retarding concrete admixture like "Plastiment R" or approved equivalent.

c) **Water reducing admixtures**

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like "Sikament" or approved equivalent.

d) **Air entraining admixtures**

- Modified lignosulphonate based air entraining concrete admixture like “FLOMO AEP " or surface active agents like "Sika AER" or approved equivalent.

e) **Water proofing admixtures**

- Modified lignosulphonate based waterproofing admixture like "Plastocrete Super" or approved equivalent.

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer:

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer’s specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value, infra red analysis & solid content).

2.05.06 **Reinforcement**

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

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain up-to-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 ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the type & different types of cement shall not be intermixed.

2.06.03 **Aggregates**

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk- heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

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 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. Tests for grading, moisture content and impurities.

c) Water : Impurities tests.

d)	Cement	:	Tests to satisfy relevant IS Specifications (If Contractor's supply).
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 (If Contractor's supply).
g)	Grades of concrete	:	Usage and mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded & Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, their limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

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

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS: 456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in any of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS: 3370 will be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS: 456 may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 **Mix Design Criteria**

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations:

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete adopted in design and specified on drawings by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS: 456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables are included in the specification. For identical condition if values given in the tables shown herein below are different from those mentioned in IS: 456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE – I

STRENGTH REQUIREMENT OF CONCRETE

Grade Designation	Specified Characteristic Compressive strength of 150 mm Cube at 28 days **(All values in N/Sq.mm)**
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40

Note - 1 : Nominal mix concrete of proportions M7.5 or M10 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling.

Note - 2 : Grades of concrete lower than M20 shall not be used in reinforced concrete.

TABLE - II
MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm Size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-150 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note - 1 : Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

Note - 2 : It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

Note - 3 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where Ordinary Portland Cement or Portland Slag Cement is used shall be as per Table-2 of IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00 **Minimum Cement Content**

The minimum cement content recommended for each grade of concrete will be as shown below as per Table 5 of IS: 456.

TABLE - III

MINIMUM CEMENT CONTENT SPECIFIED FOR DIFFERENT GRADES OF CONCRETE

Grade of Concrete	Minimum Cement Content/Cu.M of Finished Concrete
M 15	Kg 240
M 20	Kg 300
M 25	Kg 300
M 30	Kg 320
M 35	Kg 340
M 40	Kg 360

The minimum cement contents mentioned above are for average conditions and for 20 mm size aggregate. For 40 mm size aggregate the cement content may be reduced (Refer Table 6 of IS: 456).

In case the cement content can be reduced due to continuous and consistent favourable conditions, on account of better quality of cement or by the addition of suitable plasticizer / super plasticizers, then the Engineer may instruct lower cement content, and the Contractor shall abide by the stipulations laid down hereunder:

a) The Contractor shall design the mixes for 10% (Ten per cent) higher strength over and above those specified in Table - I under Clause 3.4, for the various grades of concrete and different slump requirements.

b) 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.

c) 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.

d) 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.

In case there is a downward revision of the minimum cement content from that specified in the contract, the particular unit rate of concrete will be reduced by an amount equal to the cost of cement saved, calculated at the issue rate. The relevant cost of wastage and handling on the cement saved, which is inherent in the total cost of structure, will not be deducted from the unit rate and will thus pass on to the Contractor.

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-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**

Tables 3, 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

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

The water cement ratio between 0.4 and 0.45 is generally found desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super- plasticizer. However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

3.08.00 **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 - IV

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion 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. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7of IS: 456 shall be carried out.

3.09.00 **Size of Coarse Aggregates**

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer:

Very narrow space	-	12 mm
Reinforced concrete except foundation	-	20 mm
Ordinary Plain concrete and Reinforced concrete foundations	-	40 mm
Mass concrete	-	80 mm
Mass concrete in very large structure	-	150 mm

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

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

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent

aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

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

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS: 2722 may be used.

Batching plant conforming to IS: 4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within ± 1% of the quantity of Cement, water or total aggregates being measured and within ± 3% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

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

3.11.00 **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying 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, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 **Placing and Compacting Concrete**

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation
b) Rock foundation
c) Formwork
d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out, steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The temperature of concrete shall not exceed 40 deg C measured at discharge into the works. However, for STG Top Deck and foundations for rotating equipments the temperature at discharge point of concrete shall not exceed 28 degree C or as per the instruction of the Engineer.

The maximum allowable temperature differential between any two points in the same element is 15 deg Additional temperature control measures during construction (such as use of insulated formwork) shall be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements.
The temperature monitoring of concrete work is required where:

a) the minimum dimension of any casting is 0.8m or more, or

b) where otherwise instructed by the Engineer

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken

in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the locations of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 **Cold Joint**

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness will be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the

concrete to required shape and preparing the surface as described under 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 and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anticorrosive coating on the enforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

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

3.14.02 **Finishing Unformed Surface**

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below:

a) **Floor**

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) **Beams, Columns & Walls**

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 **Protection and Curing of concrete**

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials & kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer’s supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision

regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or pay for the part where adequate curing was not noticed at a reduced rate, entirely at the discretion of the Engineer.

3.16.00 **Reinforcement**

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 **Bar Bending Schedules**

The Contractor shall submit to the Engineer for approval of Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 **Cleaning**

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

3.16.03 **Cutting & Bending of Reinforcement**

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete.

Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars

above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding**

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position 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 any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS: 456 and IS: 7861(Part II).

3.18.00 **Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by precooling, postcooling or any other method, if required, will be specified and paid for separately.

3.19.00 **Concreting under water**

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14.2 of IS: 456.

3.20.00 **Form Work**

3.20.01 **General**

The formwork shall be designed and constructed as per clause 11 of IS 456. Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the

working load. In case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 **Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings , saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 **Design**

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

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete. Regarding design and detailing of formwork, reference may be made to IS 14687.

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**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed 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.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE – V

SCHEDULE OF REMOVAL OF FORM

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

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.06 **Tolerance**

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer:

For -	a)	Sectional dimension	-	$\pm$ 5 mm
	b)	Plumb	-	1 in 1000 of height
	c)	Levels	-	$\pm$ 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 **Re-use of Forms**

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used / re-used if declared unfit or unserviceable by the Engineer.

3.20.08 **Classification**

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer:

a) **Ordinary**

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood**

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit □hosphate□n 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.

d) **Metal Decking**

The metal decking shall consist of cold rolled light gauge mild steel sheets conforming to IS: 513 having a troughed profile and a minimum thickness of 0.8 mm. The troughed profile of the sheet shall be such that the depth of the valley is minimum 44 mm and center to center of the valley is about 130 mm. The decking sheets are to be □hosphate on both sides conforming to IS: 3618. The phosphating shall be medium duty B class conforming to the above code. Over the phosphating the decking sheets shall be coated with one coat of chlorinated rubber paint applied on outside face at the manufacturer's work. Metal deck shall be installed strictly in accordance with manufacturer's recommendations.

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, Pipes and other Miscellaneous Embedded Fixtures**

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded -

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structures to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any misc. embedments and fixture as may be required.

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

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) **Bitumen Board**

Bitumen impregnated fiber board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) **Expanded Polystyrene Boards**

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 **Joint Sealing Strips**

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) **Rubber Sealing Strips**

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 – 30 N/Sq.mm
Max. Safe Continuous Temperature	:	75 Deg.C
Ultimate Elongation	:	Not less than 350%

b) **P.V.C. Sealing Strips**

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly:

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 – 15 N/Sq.mm
Max. Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 **Joint Sealing Compound**

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 **Isolation Joints**

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 **Rubber Pad**

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness – 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 **Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. Finished grout shall be cured to ensure proper strength. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, without any extra cost to the owner.

Alternatively non-shink, free flow, cementious grout like "Sikagrout 214 / Ankor NSG" / Masterflow 918 or approved equivalent specifically selected for the type of equipment to be located (vibrating , static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 **Concrete for Special Work**

3.25.01 **Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportions) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centering 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.

3.25.02 **Construction by Slip/Jump/Climb form Method**

Slip/Jump/Climb form method of construction when considered by the Bidder, type of process proposed for formwork should be indicated in the bid along with sketches, drawings and construction methods statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress (in case of slip form) 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 Bidder should furnish a brief but comprehensive report indicating the planning and method of work to be followed at the time of submitting the Bid. This report shall include the following items :

Type and description of (Slip/Jump/Climb) formwork proposed along with Equipment and its accessories.

i) Design of scaffolding and staging.

ii) Description of materials including admixtures to be used for construction.

iii) Manpower planning, construction spaces required and standby arrangement.

iv) Temporary Lightning arrestor arrangement.

v) Rate of Slip-forming/average rate of Jumps/Climbs per week.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality and safety assurance programme.

viii) Method of Transportation of material

ix) Planned interruption, if proposed and activities during planned interruption.

x) Treatment of construction joints.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

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

Notwithstanding what have been specified in earlier clauses, following guidelines are being presented which should be kept in view by intending Bidders, while quoting for Slip/Jump/Climb form method of construction:

1. Care to be taken to prevent dragging of concrete alongwith upward movement or removal of the shuttering. For this purpose following steps are advisable:

    a) Shutter plates have to be smooth and should be thoroughly clean.

    b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that the minimum slipping rate of slip form is 100 mm per hour.

    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 the type of aggregates used.

    d) Mix design also should be so done that it has a slump of minimum 50 mm at the point where concrete is placed under the ambient temperature conditions. This will also keep the required vibration by needle vibrators to 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 the mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement and aggregates proposed to be used. The admixtures shall be used strictly as per the manufacturer's Specification.

    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 higher than 40 Deg.C.

2. Care must be taken to prevent twist, which predominantly occurs 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 endeavor has to be made to eliminate 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 or A-Frame and hoist has to be fairly equal.

   c) Sleeves, through which the jacking rod passes for slip form shuttering, has to be of sufficient length so that the latter gets a uniform clearance and does not get any chance to tilt. Sleeves 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. 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 3700 Sq.Cm./gramme.

   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 offer 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.

   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 400 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 not be less than 0.1 MPa.

   e) It is advisable to use cement from a single source during the entire operation of shell casting using slip form technique since once the operation starts, there might not be any time left for conducting further trial for design mixes if the source of procurement of cement changes.

5. Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter. 40 mm diameter may be used only in exceptional cases. Sufficient numbers (at least two) of standby vibrator units should always be maintained on top of working deck at all times during the entire period of shell casting operation.

6. Proper arrangement has to be made for adequate supply of curing water for continuous spraying on both inside and outside surfaces with spraying equipment. Necessary length of pipelines and pumps of adequate capacity and head to serve the purpose shall be made available with Stand-by arrangements.

   Membrane curing compounds may be allowed on fresh surfaces emerging out of shutter panels for curing. The applied compound has to be removed suitably before further surface treatment. If curing compound is to be used then the compound to be applied should be such that it may be removed easily without leaving any stain on the concrete surfaces.

7. 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 the jacking system, based on which the slip/climbing form system works, should consist of jacks 3 Tonne to 6 Tonne capacity and 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.

   Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

8. 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.

9. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

10. 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.

11. 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/climbing 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.

12. 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 formwork system.

13. For Slip form process, in particular, it is desirable to have a planned 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.

14. 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.

15. If concrete is to be placed using concrete pumps then the complete operation such as mix design, transportation and placing of concrete, availability of sufficient equipment such as truck mixers, concrete pumps, placer booms etc. should be well planned and ensured before the concreting activities commence.

16. The slipform 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 slipform.

17. The vertical alignment must be checked constantly using laser equipment. Further manual checks should be performed using plumb bobs, theodolites or other means.

18. 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) Formwork 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 and new concrete as soon as it comes out of shutter panel.

19. It is preferable to suspend the construction work under high wind condition and high lightning frequency.

20. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slip/Jump/Climb 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.

21. Operation of slip/Jump/Climb form method of construction is practically a continuous/continual operation and demands continuous and intermittent 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.

22. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

    Safety measures as listed below must be adhered to but should not be limited to only these :

    a) Safety helmets and belts to be provided to a supervising staff and workers.

    b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

    c) Handrailing & toe guard to be provided around all openings & 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 slipform method of construction.

    g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

23. Permissible construction tolerances should be limited to the following:
    Variation in wall thickness : (-) 5 mm, (+) 25 mm

    Variation from Design Diameter : (+_) 12.5 mm per 3 m dia., 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.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

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

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

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

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

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

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

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

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

3.26.03 **Waterproofing Admixtures**

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %.

The maximum permissible dosage of admixture will be 3 % (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used as per manufacturer's specification to provide a waterproof concrete.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete – N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "No leek CP/ Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 **Bituminous or Tar Coating on External Surface**

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS: 216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/ rubber protective coating of approved manufacturer.

3.26.05 **Protective Coating on Inside Surface**

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

3.26.06 **Bitumen Felt : Application for Tanking**

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

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

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

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls is required, these will be paid extra under suitable items in the contract. A 10 (ten) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

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) @ of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm. Brown craft paper laminated as (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M10 or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 **Protective coating on Concrete Surface**

3.27.01 **On Foundation**

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

3.28.00 **Waterproofing by Pressure / Chemical Grouting**

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non- shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.m and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/ slabs) shall not be less than 700 microns.

4.00.00 **SAMPLING AND TESTING**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 **Cement**

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him without any expense to the owner. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 **Aggregates**

The Contractor shall carry out any or all the tests for aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 **Water**

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS: 3025 & IS: 456.

4.05.00 **Admixture**

4.05.01 **Air Entraining Agents (A.E.A)**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-à-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. Thereafter, the tests shall be carried out at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 **Other Admixtures**

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner.

4.06.00 **Concrete**

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS: 456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS: 456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor without any extra cost to the owner. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 **ACCEPTANCE CRITERIA**

5.01.00 **Standard Deviation**

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 9.2.4 of IS: 456.

5.02.00 **Acceptance Criteria**

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

5.03.00 **Inspection and Core Tests**

Inspection of concrete work immediately after stripping the formwork and Core Test, Non-destructive Tests of structures shall conform to Clause 17 of IS: 456.

5.04.00 **Load Test**

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Tests for flexural members', Clause 17.6 of IS: 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to full dead load of the structure plus 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 28 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS: 456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per the specification. The entire cost of dismantling and replacement and restoration of the site shall be borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 **LIST OF IS CODES AND STANDARDS FOR REFERENCE**

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

IS : 73 - Indian Standard Specification for Paving Bitumen

IS : 216 - Indian Standard Specification for Coal Tar Pitch

IS : 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 : 513 - Indian Standard Code of Practice for Cold Reduced Low Carbon Steel Sheet and Strip

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 (Part-II) - Indian Standard Specification for Method of Measurement Cement Concrete Works

IS : 1200 (Part-V) - Indian Standard Specification for Method of Measurement of Formwork

IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2

IS : 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement

IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers

IS: 1834 - Indian standard specification for hot applied sealing compound for joint in concrete.

IS : 1838 - Indian standard specification for Preformed Fillers for Expansion Joint in Concrete Pavement and Structures (Non Extruding and Resilient Type)

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 : 2508 - Indian Standard Specification for Low Density Polyethylene Films

IS : 2514 - Indian Standard Specification for Concrete Vibrating tables

IS : 2645 - Integral Cement water proofing compound

IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS : 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS : 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1: Pull out Test

IS : 3025 - Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - part - 1 to 37

IS : 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.

IS : 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4

IS : 3384 - Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing

IS : 3414 - Code of practice for Design and Installation of joints in Buildings

IS : 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS : 3558 - Code of Practice for use of Immersion Vibrators for Consolidating Concrete

IS : 3618 - Indian Standard Specification for Phosphate Treatment of Iron and Steel for Protection against Corrosion

IS : 3696 - Safety Code for Part-1: Scaffolding and Part 2: Ladders

IS : 3812 - Indian Standard Specification for Fly Ash for Use as Pozzolana & Admixture

IS : 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14

IS : 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS : 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS : 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers

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 (Part-I&II) - Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS : 4998 (Part - I) - Indian Standard Specification for Design of Reinforced Concrete Chimneys

IS : 5512 - Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials

IS : 5513 - Indian Standard Specification for Vicat Apparatus

IS : 5515 - Indian Standard Specification for Compaction Factor Apparatus

IS : 5751 - Indian Standard Specification for Precast Concrete Coping Blocks

IS : 5816 - Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders

IS : 5891 - Indian Standard Specification for Hand Operated Concrete Mixers

IS : 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS : 6909 - Indian Standard Specification for Supersulphated Cement

IS : 6923 - Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators

IS : 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures

IS : 7242 - Indian Standard Specification for Concrete Spreaders

IS : 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete

IS : 7251 - Indian Standard Specification for Concrete Finishers

IS : 7320 - Indian Standard Specification for Concrete Slump Test Apparatus

IS : 7861 (Part-I&II) - Indian Standard Specification for Recommended Practice for hot and cold 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

IS : 14687-Indian Standard Guidelines For Falseworks For Concrete Structures

VOLUME : VII-C

SECTION-IX

TECHNICAL SPECIFICATION
FOR
FABRICATION OF STRUCTURAL STEELWORK

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	VII-C/S-9 : 1
2.0.0	GENERAL	VII-C/S-9 : 1
3.0.0	WORKMANSHIP	VII-C/S-9 : 11
4.0.0	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	VII-C/S-9 : 20
5.0.0	INFORMATION TO BE SUBMITTED	VII-C/S-9 : 25
6.0.0	RATES	VII-C/S-9 : 26
7.0.0	METHOD OF MEASUREMENT	VII-C/S-9 : 27
8.0.0	PAYMENT	VII-C/S-9 : 28

VOLUME : VII-C

SECTION-IX

TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEELWORK

1.0.0 SCOPE

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

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified 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 approved design drawings marked 'Released for construction'.

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) Prepare and submit monthly materials reconciliation statement showing effective utilization of raw steel materials supplied from EPC contractor's store for time to time assessment of scrape generation.

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

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

2.2.0 **Work by others**

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

2.3.0 **Codes and standards**

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

IS : 800 - Code of practice for general construction in steel.

IS : 801 - Code of practice for use of cold formed light gauge steel structural members in general building construction.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Dimensions for rolled steel beams, channels and angle sections.

IS : 812 - Glossary of terms relating to welding & cutting of metals.

IS : 813 - Scheme of symbols for welding.

IS : 814 - Covered electrodes for metal arc welding of carbon and carbon manganese steel.

IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
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 fushion 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 & other wrought steel fittings
IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws & 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.

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 (Part - I to III)	-	Code of practice for protection of iron 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 (Part - I & II)	-	Code of practice for painting of ferrous metal in building
IS : 2074	-	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339	-	Specification for aluminium paints for general purposes in dual container.
IS : 2932	-	Specification for enamel, synthetic exterior type - I.
IS : 2933	-	Specification for enamel, synthetic exterior type - II.

2.4.0 **Conformity with Designs**

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

2.5.0 Materials to be used

2.5.1 General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

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

2.5.2 Steel

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

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

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

2.5.3 Electrodes

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

IS : 814 - Covered electrodes for metal arc welding structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

IS : 7280 - Base wire electrode for submerged arc welding.

2.5.4 **Bolts and Nuts**

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

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

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of 5.6 ÖA, where 'A' is the cross sectional area of the test specimen :

IS : 1367 - Technical supply conditions for threaded fasteners.

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

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

2.5.5 **Washers**

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

IS : 1977 - Structural steel (Ordinary Quality) St-42-0

IS : 2062 - Steel for general structural purpose

IS : 8500 - Structural steel - microalloyed (medium & high strength quality)

IS : 6623 - High Strength Structural Nuts

IS : 6649 - Hardened and tampered washers for high strength structural bolts & nuts.

2.5.6 **Paints**

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

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

2.6.0 **Storage of Material**

2.6.1 **General**

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

2.6.2 **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 length-wise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.6.3 **Electrodes**

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

2.6.4 **Bolts, Nuts and Washers**

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

2.6.5 **Paints**

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

2.7.0 **Quality Control**

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

2.8.0 **Standard Dimensions, Forms and Weights**

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

2.9.0 **Shop Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall, within forty-five (45) days after the award of the contract start to submit progressively for approval, the shop drawings based on the approved Design Drawings and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centre line dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

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

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.0.0 WORKMANSHIP

3.1.0 Fabrication

3.1.1 General

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

3.1.2 **Straightening Material**

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

3.1.3 **Cutting**

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

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

3.1.4 **Planning of Edges**

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

3.1.5 **Clearances**

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

3.2.0 **Bolted Construction**

3.2.1 **Holes**

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

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

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

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

3.2.2 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

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

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

3.3.0 Welded Construction

3.3.1 General

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

3.3.2 Preparation of Material

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

3.3.3 Assembling

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

The work shall be positioned for flat welding whenever practicable.

3.3.4 Welding Sequence

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

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

When required by the Engineer, welded 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.

3.3.5 **Welding Technique**

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

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

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

3.3.6 **Temperature**

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

3.3.7 **Peening**

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

3.3.8 **Equipment**

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.4.0 **Finish**

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

3.5.0 **Slab bases and caps**

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

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.6.0 **Lacing bars**

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

3.7.0 **Separators**

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

3.8.0 **Bearing Plates**

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

3.9.0 **Architectural Clearances**

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

3.10.0 **Shop Connections**

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

3.11.0 **Castings**

Steel castings shall be annealed

3.12.0 **Shop Erection**

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

3.13.0 Shop Painting

3.13.1 General

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

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

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

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

3.13.2 Inaccessible Parts

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

3.13.3 Contact Surfaces

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

3.13.4 Finished Surfaces

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

3.13.5 **Surfaces adjacent to field welds**

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

3.14.0 **Galvanizing**

3.14.1 **General**

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

3.14.2 **Surface Preparation**

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

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

3.14.3 **Procedure**

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

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

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.
Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes

damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.0.0. INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.1.0 Inspection

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

The Contractor shall provide 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.

4.2.0 Testing and Acceptance Criteria

4.2.1 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2.2 Steel

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.
All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.2.3 **Testing Criteria for checking Lamination in raw steel plates**

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

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

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

4.2.4 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

4.2.5 **Bolts, nuts and washers**

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

4.2.6 **Shop painting**

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

4.2.7 **Galvanizing**

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

4.3.0 **Tolerance**

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

4.4.0 **Acceptance**

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

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.5.0 **Delivery of Materials**

4.5.1 **General**

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

4.5.2 **Marking**

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

4.5.3 **Packing and Shipping**

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

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

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

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

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

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

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

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

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

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated here in before, 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 progressive bills of the Contractor.

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

5.0.0. INFORMATION TO BE SUBMITTED

5.1.0 With Tender

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

a) **Progress Schedule**

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

i) Preparation and approval of shop drawings

ii) Procurement of materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork

v) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.

vi) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

vii) Final date of completion of all shipments

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

b) **Shop**

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

c) **Matching Steel**

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

5.2.0 After Award

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

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to 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 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) 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 and scrap.

d) Results of any test as and when conducted and as required by the Engineer.

e) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

6.0.0 RATES

6.1.0 General

In general, even though it may not be specifically mentioned in the Schedule of Items, the rates for items mentioned in the Schedule of Items shall include cost of all materials consumed in the work or incidental to it, hire charges of tools and plants, cost of labour, insurance, all transport charges including taking delivery of raw steel from Contractor's Site Stores and transporting the same to the Contractor's fabricating workshop and delivery of finished fabricated materials ~~back~~ to sites, all taxes, royalties,, making approaches, security and safety arrangements, power, fuel, lubricant, preparation of all fabrication drawings, material lists, cutting lists, bolt lists, field welding schedule, services, supervision, overheads, profits etc. complete in all respects unless certain items specifically excluded by the terms and conditions of the Contract and as mentioned in the following sub-clauses.

6.2.0 Fabrication

The rates quoted for fabrication of various categories of steelwork shall specifically include taking delivery and transport of raw steel from the stockyard as mentioned in the Contract upto the Contractor's fabricating shop and one shop coat of approved metal protection paint but exclude any transport of the fabricated materials. The rates for fabrication shall also include supply of all electrodes required for shop and field work including 10% extra for field work.

6.3.0 Transport

The rate quoted for transport shall include all C.I.F. from the Contractor's fabricating shop upto the Site and loading of the fabricated materials on railway wagons or trucks at the fabricating shop but shall generally exclude unloading at site(which is generally included in the rate for erection). But, in case the terms & conditions of the contract so desire, the cost of unloading of the fabricated material at site shall also be included in the quoted rates for transport.

6.4.0 **Bolts, nuts and washers**

The rates quoted for the supply of bolts, nuts and washers shall include the total cost of delivery of the materials at site or to the Owner's Site stores as directed by the Engineer.

7.0.0 **METHOD OF MEASUREMENT**

7.1.0 **Fabrication**

Measurement shall be in tonnes and based on the unit weights as per relevant Indian Standards and on the following considerations : -

a) All members, except plate works paid under rates for bunkers, tanks, etc., will be measured square.

b) All plate works paid under rates for bunkers, tanks, etc. as applicable will be measured as actual.

c) No deduction will be made for bolt and/or holes and/or holes upto 25 Sq.Cm.

d) Unless otherwise specified no allowance shall be made for weld metals in case of welded steel structure.

7.2.0 **Supply of bolts, nuts and Washers**

The supply of bolts, nuts and washers will be measured on standard unit weight basis or actuals whichever is less.

7.3.0 **Transport**

The measurement for transport of fabricated steelwork will be for the net weight of the fabricated materials as measured under Sub-clause 7.1.0 excluding the weight of all packing and supporting materials necessary for transport.

8.0.0 **PAYMENT**

Unless mentioned otherwise in the tender / contract document, for fabricated materials delivered to Site, the Contractor shall be entitled to 90% of the value of the materials supplied and the balance 10% shall be paid only after the final erection, and aligning of the fabricated materials. In addition, the Security Money as stipulated in the Contract, shall be deducted from each payment.

VOLUME : VII-C

SECTION-X

TECHNICAL SPECIFICATION
FOR
ERECTION OF STRUCTURAL STEEL WORK

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	VII-C/S-X : 1
2.0.0	GENERAL	VII-C/S-X : 1
3.0.0	WORKMANSHIP	VII-C/S-X : 5
4.0.0	TESTING AND ACCEPTANCE CRITERIA	VII-C/S-X: 12
5.0.0	INFORMATION TO BE SUBMITTED	VII-C/S-X : 17
6.0.0	RATES	VII-C/S-X : 18
7.0.0	METHOD OF MEASUREMENT	VII-C/S-X : 18
8.0.0	PAYMENT	VII-C/S-X : 19

VOLUME : VII-C

SECTION-X

TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEEL WORK

1.0.0 SCOPE

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

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

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

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.2.0 **Work by others**

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

2.3.0 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent :

IS-800	:	Code of Practice for general construction in steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12843	:	Tolerance for erection of Steel Structures

2.4.0 **Conformity with designs**

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

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

2.5.0 **Material**

2.5.1 **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor for erection work will take delivery of all the materials from the Contractor's Stores or storage yard at Site. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.5.2 **Materials to conform to Indian Standards**

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

2.6.0 **Storage of materials**

2.6.1 **General**

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

2.6.2 **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.6.3 **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.

2.7.0 **Quality control**

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

a) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

b) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.8.0 **Taking Delivery**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks and/or the Owner's stores at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection 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 erection 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.

3.0.0 **WORKMANSHIP**

3.1.0 **Erection**

3.1.1 **Plant and equipment**

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

3.1.2 **Method and sequence of erection**

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

3.1.3 **Temporary bracing**

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, 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 responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.

3.1.4 **Temporary floors for buildings**

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

3.1.5 **Setting out**

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor

shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

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

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

3.1.6 **Field bolting**

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

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

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 8xdia. 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.

3.1.7 **Field Welding**

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

3.1.8 **Holes, cutting and fitting**

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

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

3.2.0 **Drifting**

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

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

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

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

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

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

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like Conbextra-GP-1 or "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, 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 leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.4.0 **Painting after erection**

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

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

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

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

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.5.0 **Stainless Steel Plate Lining in Bunker Hopper**

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

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

3.6.0 **Final cleaning up**

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

3.7.0 **Safety Measures during Erection**

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

4.0.0 **TESTING AND ACCEPTANCE CRITERIA**

4.1.0 **General**

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. 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 responsible,

to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

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

4.1.1 **Stiffness Test**

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

4.1.2 **Strength Test**

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

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 **Structure of same design**

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

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

4.1.4 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 herein before 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. herein before.

4.2.0 **Tolerances**

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

I. **For Buildings Containing Cranes**

Component	**Description**	**Variation Allowed**
Main columns	a) Shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) $\pm$ 3.0 mm
	ii) In lateral direction	ii) $\pm$ 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) $\pm$ 3.5 mm from true vertical

Component	Description		Variation Allowed
	ii)	For a column greater than 10M but less than 40M height any 10M	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 levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm which ever is the least
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports	1/250 of depth of truss or 20 mm whichever is the least

Component	Description		Variation Allowed
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
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.

4.3.0 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 Before Tender

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

5.1.1 Tentative Programme

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

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

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

5.1.3 Erection yard

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

5.2.0 After award of the Contract

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

5.2.1 Detailed Programme

The Contractor shall submit a detailed erection programme 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.

5.2.2 **Fortnightly Progress Report**

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

6.0.0 **RATES**

Even though it may not be specifically mentioned in the Schedule of Items, the rates shall include all work to be provided by the Contractor in accordance with Sub-clause 2.1.0 of this Contract and cost of all materials and labour required to complete the work or incidental to it, hire charges of Constructional Plant and Equipment and erection tools, insurance, all necessary transport, taxes and royalties, making necessary arrangements for approaches, yard, security, safety and other facilities, power, fuel, lubricant, services, supervisions, overheads, profits etc. complete in all respects. It shall also include cost of all other work and supplies not specifically mentioned but reasonably implied as being necessary to complete the works in all respects in accordance with the Contract.

7.0.0 **METHOD OF MEASUREMENT**

7.1.0 **Erection**

All measurement shall be in tonnes and based on the theoretical unit weights as per Indian Standard and on the following considerations :

a) All members, except plate work paid under rates for bunkers, tanks, etc. shall be measured square.

b) All plate work paid at rates for bunkers, tanks, etc. shall be measured as actual.

c) No deduction shall be made for bolt and/or holes for other purposes upto 25 Sq.cm. in area.

d) Unless otherwise specified in the case of welded steel structure, no allowance shall be made for the weld metal.

e) No separate payment shall be made for field connection materials such as permanent bolts, nuts, washers, erection bolts and nuts. No extra payment shall be made for site welding.

7.2.0 **Grouting**

The measurement of grouting the stanchion and other base plates shall be on the basis of theoretical volume of the voids to be filled in Cu.M. without any deduction for the volume of embedments. Edges of the grouting shall be measured square neglecting chamfers, if any.

7.3.0 **Painting**

The finish painting, other than touch up and other painting, if required to be done within the quoted rates as per this Specification, shall be measured on the basis of the tonnage of the structure erected and painted calculated on the basis of Sub-clause 7.1.0.

8.0.0 **PAYMENT**

Unless mentioned otherwise in the Tender/Contract document for fabricated materials erected, aligned, plumbed, levelled and grouted, the Contractor shall be paid 95% (ninety-five percent) of the value of erection. the balance 5% (five percent) shall be paid after acceptance of the structure withstanding necessary tests in accordance with the Contract. Necessary deductions towards Security Money shall be made from all bills of the Contractor in accordance with the Contract.

VOLUME : IIG/3

SECTION-XI

TECHNICAL SPECIFICATION
FOR
ROADS AND DRAINAGE

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	V2/G-3/S-XI : 1
2.00.00	GENERAL	V2/G-3/S-XI : 1
3.00.00	EXECUTION	V2/G-3/S-XI : 6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	V2/G-3/S-XI : 26

VOLUME : IIG/3

SECTION-XI

TECHNICAL SPECIFICATION FOR ROADS AND DRAINAGE

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, preparation of sub-base, water bound macadam, bituminous macadam, wearing course etc. excluding toppings and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Notwithstanding the provisions of the technical specification, all road works shall be carried out as per IRC / MORT&H specification.

This specification also includes all work required for drainage including road side RCC drain, RCC culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

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

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

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 Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 **Work to be provided for 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, 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 Road Transport & Highways (Fourth Revision). Published by the IRC, New Delhi-2001.

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 : 783 Code of Practice for Laying of Concrete Pipes.

6. IRC : 36 Recommended Practice for Construction of Earthen embankments for Road Works.

7. IRC : 37 Guidelines for the design of Flexible pavements

8. 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 Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer. Material to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in MORT&H Specification and specification for relevant items of work carried under these specifications.

2.06.00 **Control of Alignment, Level and Surface Regularity**

The Contractor 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 Engineer. Permitted tolerances for roadworks are described hereinafter.

i) **Horizontal Alignments**

Horizontal alignments 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± 10 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be± 25 mm.

ii) **Surface Levels**

The levels of the subgrade 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 beyond the tolerances mentioned in Table1.

TABLE-1.

TOLERANCES IN SURFACE LEVELS
(Table 900-1 of MORT&H)

1.	Subgrade		+ 20 mm - 25 mm
2.	Sub-base + 10 mm :		
	a)	Flexible pavement	- 20 mm
	b)	Concrete pavement (Dry lean concrete or Rolled concrete)	+ 6 mm - 10 mm
3.	Base-course for flexible pavement		
	a)	Bituminous course	+ 6 mm - 6 mm
	b)	Other than bituminous	+ 10 mm
		i) Machine laid	- 10 mm + 15 mm
		ii) Manually laid	- 15 mm

4.	Wearing course for flexible pavement :		
	a)	Machine laid	+ 6 mm - 6 mm
	b)	Manually laid	+10 mm -10 mm
5.	Cement concrete pavement		+ 5 mm - 6 mm *

* This may not exceed - 8 mm at 0- 30 cm from the edges.

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

TABLE-2

MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES
(Table 900-2 of MORT & H)

	Surfaces of Carriageways and paved shoulders				Surfaces of laybys, service areas and all bituminous base courses			
Irregularity	4mm		7mm		4mm		7mm	
Length (m)	300	75	300	75	300	75	300	75
National Highways/ Expressways*	20	9	2	1	40	18	4	2
Roads of lower category*	40	18	4	2	60	27	6	3

*Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

for pavement surface (bituminous and cement concrete)	3 mm
for bituminous base courses	6 mm
for granular sub-base/base courses	8 mm
for sub-bases under concrete pavements	10 mm

2.07.00 **Rectification**

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

i) Subgrade : Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305 of MORT&H.

ii) Granular sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401 of MORT&H.

iii) Water Bound Macadam/Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406 of MORT&H.

iv) Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less that 3.5 m in width.

2.08.00 **Quality Control Tests During Construction**

As per Clause 903 of MORT&H specification.

3.00.00 **EXECUTION**

3.01.00 **Shoulder**

3.01.01 **Description**

This work shall consist of constructing shoulders on either side of the pavement in accordance with the requirements of MORT&H specification and in conformity with the lines, grades and cross- sections shown on the drawings or as directed by the Engineer.

3.01.02 **Materials**

Shoulder may be of selected earth/ granular material/paved conforming to the requirements of MORT&H specification.

3.01.03 **Construction Operations**

Shoulder

The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of earth shoulder layer. The adjacent layers having same material shall be laid and compacted together.

Compaction requirement of earthen shoulder shall be as per latest MORT&H specification. In the case of bituminous course, work on shoulder (earthen/hard/paved), shall start only after the pavement course has been laid and compacted.

During all stages of shoulder (earthen/hard/paved) construction, the required crossfall shall be maintained to drain off surface water.

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 damage to the pavement, and the area so affected thoroughly cleaned.

3.02.00 **Sub-base (Granular Sub-base)**

3.02.01 **Description**

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of MORT&H specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.02.02 **Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 3.

While the gradings in Table 3 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 4. The grading to be adopted for a project shall be as specified in the Contract.

TABLE-3

GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS (TABLE 400-1 of MORT&H)

IS Sieve Designation	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	80-100	100	-
26.5 mm	55-90	70-100	100
9.50 mm	35-65	50-80	65-95
4.75 mm	25-55	40-65	50-80
2.36 mm	20-40	30-50	40-65
0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

TABLE-4

GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS
(Table 400-2 of MORT&H)

IS Sieve Designation	Per cent by weight passing the IS Sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	<10	<10	<10
CBR Value (Minimum)	30	25	20

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

3.03.03 **Physical Requirements**

The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent.

3.03.04 **Spreading and Compacting**

The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part II) and 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 is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). 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 started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions 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 corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 95% of the maximum dry density for 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 material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 Water Bound Macadam Sub-base/Base Course

3.04.01 Description

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling,, and bonded together with screenings, binding material, where necessary and water, laid on a prepared subgrade or sub-base, as the case may be, and finished in accordance with the requirements of MORT&H Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer.

3.04.02 **Materials**

3.04.02.1 **Coarse Aggregates**

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quantity. The aggregates shall conform to the physical requirements set forth in Table 5.

TABLE 5 (Table 400-6 of MORT&H)

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES

	Test	Test Method	Requirements
1.	* Los Angeles Abrasion value Or * Aggregate Impact value	IS : 2386 (Part-4) IS : 2386 (Part-4) or IS : 5640 **	40 per cent (Max) 30 per cent (Max)
2.	Combined Flakiness and Elongation Indices (Total) ***	IS : 2386 (Part-1)	30 per cent (Max)

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS : 5640.

*** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

3.04.02.2 **Crushed or Broken Stone**

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 **Grading Requirements of Coarse Aggregates**

The coarse aggregates shall conform to one of the gradings given in Table 6, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE 6 (Table 400-8 of MORT&H)

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size Range	IS Sieve Designation	Per cent by Weight passing
1.	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2.	63 mm to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Gradings e.g. 2 & 3, it shall be 75 mm.

3.04.02.4 **Screenings**

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. 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.

Screenings shall conform to the gradings set forth in Table7.

TABLE 7

GRADINGS FOR SCREENINGS (Table 400-8 of MORT&H)

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS Sieve
A	13.2 mm	13.2 mm 11.2 mm 5.6 mm 180 micron	100 95-100 15-35 0-10
B	11.2 mm	11.2 mm 5.6 mm 180 micron	100 90-100 15-35

3.04.02.5 **Binding Material**

Binding material to be used for water bound macadam as a filter material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m3/10m2 and 0.08-0.10m3/10m2 for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.04.03 **Construction Operations**

3.04.03.1 **Preparation of Base**

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 dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

3.04.03.2 **Inverted Choke**

If the water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared subgrade before application of the coarse aggregates is taken up.

3.04.03.3 **Spreading Coarse Aggregate**

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 **Rolling**

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or 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, in successive passes uniformly lapping preceding tracks by at least one half width.

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 subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 **Applications 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 aggregate. 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 spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

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, hand-brooms or 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 aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 **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 sweep the wet screenings into voids and to distribute them evenly.

The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 **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, the resulting slurry 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 of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 **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 has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 **Tack Coat**

3.05.01 **Description**

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of bituminous mix, when specified in the Contract or instructed by the Engineer.

3.05.02 **Materials**

Binder: The binder used for tack coat shall be bitumen emulsion complying with IS: 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

3.05.03 **Construction Operations**

3.05.03.1 **Preparation of Base**

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom and high pressure air jet, or by other means as directed by the Engineer.

3.05.03.2 **Application of tack coat**

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. The normal range of spraying temperature for a bituminous emulsion shall be 20 degree Celsius - 70 degree Celsius and for a cutback 50 degree Celsius – 80 degree Celsius if RC-70/MC-70 grade is used. The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

3.06.00 **Bituminous Macadam Binder Course**

3.06.01 **Description**

This work shall consist of construction, in a single course, of 50 mm to 100 mm thickness or in multiple courses of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of MORT&H Specifications.

3.06.02 **Materials**

3.06.02.1 **Bitumen**

The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specifications for “Paving Bitumin”IS: 73, and of the penetration indicated in table 500-4 of MORT&H

3.06.02.2 **Coarse Aggregates**

The aggregates shall consist of crushed stone, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where crushed gravel is used, not less than 90 per cent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces.

The aggregates shall satisfy the physical requirements set forth in Table 8.

TABLE 8 (Table 500-3 of MORT&H)

PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR BITUMINOUS MACADAM

Property	Test	Specification
Cleanliness	Grain size analysis	Max 5 % passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (combined)2	Max 30%
Strength	Los Angeles Abrasion Value Aggregate Impact Value	Max 40% Max 30%
Durability	Soundness : Sodium Sulphate Magnesium Sulphate	 Max 12% Max 18%
Water Absorption	Water Absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Min 80%

3.06.02.3 **Fine aggregates**

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter

3.06.02.4 **Proportioning of Materials**

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of table 500-4 of MORT&H.The binder content shall be within a tolerance of

3.06.03 **Construction Operations**

3.06.03.1 **Weather and Seasonal Limitations**

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 **Preparation of Base**

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 **Tack Coat**

A tack coat shall be applied over the base.

3.06.03.4 **Preparation and Transport of Mix**

It would be carried out as per Clause 501.3 and 501.4 of MORT&H

3.06.03.5 **Spreading**

It would be carried out as per Clause 501.5.3 of MORT&H.

3.06.03.6 **Rolling**

It would be carried out in accordance with the provisions of Clauses 501.6 and 501.7 of MORT&H.

3.07.00 **Bituminous Concrete**

3.07.01 **Scope**

This clause specifies the construction of bituminous concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

3.07.02 **Materials**

3.07.02.1 **Bitumen**

The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specification for Paving Bitumen. IS:73 and of the penetration indicated in Table 500-18 of MORT&H, for bituminous concrete or this bitumen as modified by one of the methods specified in clause 521 of MORT&H, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

3.07.02.2 **Coarse Aggregates**

The coarse aggregates shall be generally as specified in clause 507.2.2 of MORT&H, except that the aggregates shall satisfy the physical requirements of Table 500-17 of MORT&H.

3.07.02.3 **Fine Aggregates**

The fine aggregates shall be all as specified in clause 507.2.3 of MORT&H.

3.07.02.4 **Filler**

Filler shall be generally as specified in clause 507.2.4 of MORT&H. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 of MORT&H then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

3.07.02.5 **Aggregate grading and binder content**

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall

Within the limits shown in Table 500-18 of MORT&H for gradings 1 or 2 as specified in the Contract.

3.07.03 Mixture Design

3.07.03.1 Requirements for the mixture

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-19 of MORT&H.

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORT&H.

3.07.03.2 **Binder content**

The binder content shall be optimised to achieve the requirements of the mixture

Set out in Table 500-19 of MORT&H and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

3.07.03.3 **Job mix formula**

The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 of MORT&H as obtained by the Contractors.

3.07.03.4 **Plant trials-permissible variation in job mix formula**

The requirements for plant trials shall be all as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 as obtained by the contractors.

3.07.03.5 **Laying trials**

The requirements for plant trials shall be all as specified in clause 507.3.5 of MORT&H.

3.07.04 **Construction Operations**

3.07.04.01 Weather and seasonal limitations

The provisions of clause 501.5.1 of MORT&H shall apply.

3.07.04.02 **Preparation of base**

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with clauses 501 and 902 of MORT&H as appropriate, or as directed by the engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the engineer.

3.07.04.03 **Tack coat**

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of clause 503 of MORT&H.

3.07.04.04 Mixing and transportation of the mixture

The provisions as specified in clauses 501.3 and 501.5.4 of MORT&H shall apply.

3.07.04.05 **Spreading**

The general provisions of clauses 501.5.3 and 501.5.4 of MORT&H shall apply.

3.07.04.06 **Rolling**

The general provisions of clauses 501.6 and 501.7 of MORT&H shall apply, as modified by the approved laying trials.

3.07.05 **Opening to traffic**

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the engineer in writing.

3.07.06 **Surface finish and Quality control**

The surface finish of the completed construction shall conform to the requirements of clause 902 of MORT&H. All materials and workmanship shall comply with the provisions set out in section 900 of this specification.

3.07.07 **Arrangements for traffic**

During the period of construction, arrangements for traffic shall bemade in accordance with the provisions of clause 112 of MORT&H.

3.08.00 **Road Side Drains**

3.08.01 **Formation of Drains**

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per Dwg.

3.09.00 **Culverts**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer 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.

3.10.00 **Pipe Culverts and Drainage Pipes**

3.10.01 **Materials**

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458-Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland cement as per IS: 8112 - Latest edition.

Aggregates shall be as per IS: 383 - Latest edition - 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 - Latest edition.

3.10.02 **Laying of Pipes**

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor 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 without any extra cost to the Owner. Side slips, if there be any, shall be removed by the Contractor without any extra cost to the Owner. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose clods and lumps

broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level 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 material, 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.

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 not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS: 783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a mix not leaner than M25. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has 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 regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or 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 remaining height of block to be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.10.03 **Relation with Water Supply Pipeline**

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.11.00 **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 exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be watertight 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 Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.12.00 **Plaster to Concrete**

Before application of plaster the surface shall be 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 water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. 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. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall

be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS: 1661- latest edition.

3.12.01 **Finish**

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a 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.

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 section 900 of MORT&H shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS: 456.

VOLUME : VII-C

SECTION-XIII

TECHNICAL SPECIFICATION FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XIII : 1
2.00.00	MATERIALS	VII-C/S-XIII : 1
3.00.00	STORAGE AND HANDLING OF MATERIALS	VII-C/S-XIII : 6

VOLUME : VII-C

SECTION-XIII

TECHNICAL SPECIFICATION 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 omit 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.

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 Contractor's own cost.

TABLE-1

Class Designation	Average compressive strength			
	Not less than		Less than	
	N/mm^2	(kg/cm^2)	N/mm^2	(kg/cm^2)
12.5(125)	12.5	(125)	15.0	150
10 (100)	10	(100)	12.5	125
7.5 (75)	7.5	(75)	10	100
5 (50)	5	(50)	7.5	75
3.5 (35)	3.5	(35)	5.0	50

ii) Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Lime Bricks (flag Bricks) shall conform to IS 12894. 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 or without frog on one of its flat side. Fly ash shall confirm to IS 3812.

Note : This item will be operated only for load bearing structure up to 2 storied and for non-load bearing walls 23cms thick for multi-storeyed buildings.

Bottom ash used as replacement of sand shall not have more than 12 % loss on ignition when tested.

Sand : Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime : Lime shall confirm to class 'C' hydrated lime of IS 712

Additives : Any suitable additive considered not detrimental to the durability of bricks may be used.

iii) **Clay Fly Ash Bricks :** The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly ash shall conform to grade I or Grade II of IS 3812.

iv) **Mechanised Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plat by appropriate proportion of fly ash and lime. 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 of 100/80 mm in length, 40 mm width and 10 to 20 mm deep 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**

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 Contractor 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
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 shaked 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 Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are up to the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the Contractor at his own expense. 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.

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 pyrities, 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.

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.

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.

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 Contractor 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.

VOLUME : VII-C

SECTION-XIV

TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XIV : 1
2.00.00	EXECUTION	VII-C/S-XIV : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XIV : 4
4.00.00	RATES	VII-C/S-XIV : 4
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XIV : 4
6.00.00	I. S. CODES	VII-C/S-XIV : 5

VOLUME : VII-C

SECTION-XIV

TECHNICAL SPECIFICATION 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**

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 though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contract 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 / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by 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 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 / M^2 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 mm and a depth of 75 mm 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 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 at no extra cost to the owner.

4.00.00 **RATES**

The rates shall include the cost of labour and all other inputs including concentrated chemical involved in all the operations described above including making holes, channels etc. Rates shall be of complete work per unit length or area as stated in the Schedule.

5.00.00 **METHOD OF MEASUREMENT**

Complete work of anti-termite treatment shall be measured as per items stated in the BOQ.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work and no extra payment shall be made.

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)
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.

VOLUME : VII-C

SECTION-XV

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORK

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTRODUCTION	VII-C/S-XV : 1
2.00.00	QUALITY ASSURANCE PROGRAMME	VII-C/S-XV : 1
3.00.00	QA AND QC MANPOWER	VII-C/S-XV : 3
4.00.00	SAMPLING AND TESTING OF CONSTRUCTION MATERIALS	VII-C/S-XV : 3
5.00.00	LABORATORY AND FIELD TESTING	VII-C/S-XV : 5
6.00.00	PURCHASE AND SERVICE	VII-C/S-XV : 5
7.00.00	MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN	VII-C/S-XV : 7
8.00.00	DISPOSITIONING OF NON CONFORMITIES	VII-C/S-XV : 8
9.00.00	QUALITY AUDIT	VII-C/S-XV : 8
10.00.00	QA DOCUMENTATION PACKAGE	VII-C/S-XV : 9
11.00.00	GENERAL QA REQUIREMENTS	VII-C/S-XV : 9
12.00.00	SHOP TEST EOT CRANES, OTHER CRANES *&* HOIST	VII-C/S-XV : 28
13.00.00	CATHODIC PROTECTION	VII-C/S-XV : 29

ATTACHMENTS

ANNEXURE-I	QA & QC ORGANISATION SETUP	VII-C/S-XV : 31
ANNEXURE-II	TYPICAL QA/QC LAB EQUIPMENT	VII-C/S-XV : 32
ANNEXURE-III	INDICATIVE LIST OF BOUGHT OUT ITEMS FOR CIVIL WORKS	VII-C/S-XV : 34
ANNEXURE-IV	INDICATIVE FIELD QUALITY PLAN	25 SHEETS
ANNEXURE-V	LIST OF VENDORS	1 SHEET

VOLUME : VII-C

SECTION-XV

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORK

1.00.00 INTRODUCTION

1.01.00 This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all civil and structural works covered in this specification.

1.02.00 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.03.00 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / contract documents shall be carried out at no extra cost to the owner.

1.04.00 The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer. If required, work methodology may be revised/ reviewed at every stage of execution of work at site, to suit the site conditions by the contractor at no extra cost to the owner.

2.00.00 QUALITY ASSURANCE PROGRAMME

2.01.00 The contractor shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipments and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the OWNER'S site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the contractor and shall be finally accepted by the OWNER or their authorized representative after discussions before the start of work. The QAP shall be generally in line with IS/ISO Systems.

The contractor shall furnish complete QA & QC programme for the work envisaged which may include the following

- Organization structure for the management and implementation of the proposed quality assurance programme
- Quality System Manual
- Design Control System
- Documentation and Data Control System
- Qualification data / details for Contractor's key personnel
- The procedure for purchase of materials, parts, components and selection of subcontractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased, etc.
- System for shop manufacturing and site erection controls including process, fabrication and assembly
- Control of non-conforming items and system for corrective actions and resolution of deviations
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring testing equipment.
- System for Quality Audits
- System for identification and appraisal of inspection status
- System for authorizing release of manufactured product to the OWNER
- System for handling, storage and delivery.
- System for maintenance of records
- Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work/ equipment/component.

3.00.00 QA AND QC MANPOWER

3.01.00 The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the contractor's QA coordinator to OWNER. OWNER shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the contractor and their sub-vendors on one hand & with OWNER on the other hand.

3.02.00 The contractor shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of contractor's QA&QC manpower required to be deployed at site is enclosed at Annexure-I. Based on the finalized L-2 network and the approved Field Quality plan, the contractor shall finalize and submit a deployment schedule of QA&QC personnel along with their details to OWNER for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

3.03.00 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the contractor shall consist of qualified and experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.04.00 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the contractor based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.00.00 SAMPLING AND TESTING OF CONSTRUCTION MATERIALS

4.01.00 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.

4.02.00 The contractor shall carry out testing in accordance with the relevant IS / standards/codes and in line with the requirements of the technical specifications/quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the engineer or his authorized representative.

4.03.00 Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as NCB-Ballabhgarh, CSMRS-Delhi, IIT's, etc. as agreed by the engineer. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the engineer.

4.04.00 The contractor shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the engineer.

4.05.00 Evaluation of aggregate for potential alkali-aggregate reactivity shall be carried out as per following scope of work

A. Evaluation of Aggregates for Mechanical / Physical Properties

a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and fiakiness index, as per IS: 2386.

b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material, soundness, silt content, clay content and organic impurities as per IS: 2386.

c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates.

B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity:

a) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test).

b) To prepare a report based on test results of a) above and to advise regarding suitability of aggregates to be used and further testing required if any.

5.00.00 LABORATORY AND FIELD TESTING

5.01.00 The field laboratory for QA and QC activities shall be constructed and set-up by the contractor in line with the indicative field QA&QC laboratory set-up enclosed at Annexure-II. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for OWNER acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.02.00 All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the OWNER. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to OWNER.

5.03.00 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by OWNER engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to OWNER.

5.04.00 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled /agreed.

6.00.00 PURCHASE AND SERVICE

6.01.00 The major items/ equipments/ components to be manufactured in the shop of the contractor i.e. in-house items and those procured from sub-vendors / sub-manufacturer / sub-contractors i.e. bought out items (BOIs) shall be listed out by the contractor in their bid proposal.

6.02.00 An indicative list of major bought out items (not exhaustive) and services for civil works is enclosed at Annexure- III, for which the contractor shall submit the requisite details / lists of manufacturer's in their bid proposal. The list of manufacturers/ sub-vendors for all the BOIs envisaged in contract shall be included in the bid proposal by the contractor which shall be discussed / reviewed by the OWNER during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the contractor shall propose the manufacturer's / sub-vendor's details for review / approval of OWNER, prior to initiating the procurement of such materials.

6.03.00 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the OWNER for approval in the prescribed OWNER format within the period agreed at the time of post bid discussions. The contractor's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed. The formats for furnishing above details shall be given to the Contractor at post bid discussion stage. Monthly progress reports on sub-contractor detail submission / approval shall be furnished. Such manufacturers / sub-vendors approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

6.04.00 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the Technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER. Approval of material / sample by the engineer shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.05.00 Structural steel supply is in the scope of the EPC contractor and shall be procured from approved vendors of APGENCO only as shown in the ANNEXURE-V. In case of non-availability of some of the sections with the approved vendors, the contractor may propose to procure the sections from the re-rollers of the main steel producers, the name of such re-rollers will have to be cleared by corporate quality assurance of OWNER for which details such as BIS approval, main steel producer's approval, past experience for production of sections of specified material, details of machines plants testing facilities etc., Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers,

that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller.

6.06.00 Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch shall be the responsibility of the contractor and these shall be performed in presence of the authorized representative of the main Contractor.

6.07.00 Reinforcement steel supply is in the scope of the contractor and shall be procured from approved vendors of APGENCO. In case any size /diameter specified is not available with main steel producers and are proposed to be supplied from the conversion agent of the main steel producer the name of such conversion agent / re-roller shall have to be approved by OWNER for which details such as BIS approval, Main steel producer's approval, Past experience for production of sections of specified material, details of machines, plants testing facilities etc., and confirmation that the process control and manufacturing of steel sections by re-rollers is the same as that of main steel producers, that billets for re-rolling are sourced from main steel producers only shall be furnished with regards to re-roller.

7.00.00 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.01.00 All materials / components and equipment covered under the scope of work, shall be procured by the contractor for the purpose of the contract, after obtaining the written approval of the OWNER, which are to be manufactured at shop/ factory of the vendor/sub vendor shall be covered under a comprehensive quality assurance programme. The contractor's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub-supplier/ sub-vendor. The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by contractor's / sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. Such quality plans of the vendors / sub-vendors shall be submitted to the OWNER for approval for MQP and such approved quality plans shall form a part of the purchase order / contract between the contractor and sub-contractor. The quality plans shall be submitted on electronic form e.g. CD or E-mail in addition to hard copy, for review and approval of OWNER. After approval the same shall be submitted in compiled form on CD in addition to hard copy.

7.02.00 The contractor shall furnish copies of the reference documents/ plant standards / acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference

documents/standards etc. will be subject to OWNER approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, OWNER shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the OWNER engineer or his authorized representative and beyond which the work shall not proceed without consent of OWNER in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to OWNER along with technical justification for approval and dispositioning.

7.03.00 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the OWNER for reference / record by the contractor along with a report of the purchase orders placed so far for the contract.

7.04.00 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) and obtain approval of OWNER, which shall detail out for all the works, equipments, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure - IV-A (Indicative FQP for civil works) & Annexure - IV-B (Indicative FQP for structural steel works).

8.00.00 DISPOSITIONING OF NON CONFORMITIES

8.01.00 The non-conformity for the site works on being detected / noted shall be reported by the contractor in the standard format of OWNER under the system of dispositioning of non conformity report (NCR) to the engineer. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction / erection shall describe the proposed correction and also include the preventive / corrective action plan for future.

9.00.00 QUALITY AUDIT

9.01.00 OWNER reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the contractor or their sub-contractor. The contractor shall provide all necessary assistance to enable the OWNER carry out such audit and surveillance. The contractor shall also take necessary measures, raise NCRs wherever required based on the audit findings / observations.

10.00.00 QA DOCUMENTATION PACKAGE

10.01.00 The contractor shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark. Typical contents of QA documentation pertaining to field activities as per approved MQP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non-destructive examination results / reports, Heat Treatment Certificate/Record, Non-conformance Reports, CHP, Certificate of Conformance (COC)and MDCC.

11.00.00 GENERAL QA REQUIREMENTS

11.01.00 The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his subcontractor's premises or at the OWNER'S site or at any other place of work are in accordance with the OWNER technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

11.01.01 Storage and Handling of Construction Materials

All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in OWNER Technical Specification.

11.01.02 Excavation and Filling Works

The contractor shall submit a work methodology covering various items of works for alt stages of excavation and filling works. This methodology shall broadly include the quantity wise and classification wise identification of source of excavation and filling, suitability tests as per specification requirements, method of stockpiling, transportation, placement, spreading , compaction, equipment, list of protocols, in-situ tests, third party lab test if required, acceptance checks for final clearance.

For blasting work at site if required, the contractor shall associate themselves with the reputed specialized blasting agency such as CMRI, NIRM for trials blasts, design blasts, blasting pattern, monitoring of blast during the blasting operations at site. The contractor shall install and operate equipment {such as tri-axial seismograph) for continuous monitoring and control of blast induced vibrations, noise level/ air pressure, dust, silica and noxious gases during all blasting operations in line with the technical specification requirements in association with the specialized blasting agency. The contractor shall submit the un-priced copy of the award on the specialized blasting agencies to OWNER, highlighting the scope of services / work awarded to them by contractor. The services of such specialized blasting agency shall be available through out the period in which the blasting work is undertaken at

site. The blasting operation shall remain in charge of a responsible, competent, authorized and experienced supervisor (man-in-charge) and thoroughly acquainted workmen, All blasting work shall be done as per approved blasting scheme/ design/ pattern in line with the technical specification requirements and all statutory laws, rules, regulations, relevant standards pertaining to the acquisition, transport, storage, handling along with use of explosives shall be strictly followed by the contractor.

Tolerance for finished surface level shall be within 20 mm of the level shown in the drawing. For an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the engineer. However, these tolerances shall be applicable for localized areas only.

Acceptance criteria shall be

a) When only one set of sample is tested, then all individual samples collected an tested should pass without any deviation

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

11.01.03 **Masonry and Allied Works**

The execution, finishing, testing and acceptance of masonry related works shall be as per the provisions of technical specifications / relevant practices IS code. Local depressions on account of faulty workmanship, broken / chipped edges shall not be acceptable.

All masonry shall be built true and plumb within the tolerances prescribed as below, Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry works shall be as below: :

Sl. No.	Type of Check	Tolerance
	Deviation in verticality in total height of any wall of a building	Shall not exceed ± 12.5mm (more than one storey) + 6mm per 3m height (within a storey)
	Deviation from the position shown on the plan of any brickwork	Shall not exceed 12.5mm (more than one storey)
	Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment	Shall not exceed 6mm

Sl. No.	Type of Check	Tolerance
	Deviation of bed joint from horizontal in any length, and it	Shall not exceed 6mm (upto 12m) Shall not exceed 12.5mm total (in any length over 12m)
	Deviation from the specified thickness of bed-joints, cross-joints or perpends	Shall not exceed ± 3mm
	Finished plastered surface	Deviation not more than 4 mm when checked with a straight edge of 2 m length placed against the surface
	The average thickness of plaster	Not be less than the specified thickness
	The minimum thickness over any portion of the surface	Not less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster

11.01.04 **Concrete Works**

For concreting works provisions of technical specifications and IS: 456 shall apply. A detailed methodology for concrete works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for concrete works shall broadly contain the suitability of source of aggregates, cement, admixture, water and reinforcement steel, etc. The available concrete mix design recommended from a specialist institute, results of trial mix carried out at site, method / control of batching, mixing, transportation, layer wise placement, compaction, fixing / removal of form work, staging, fixing of water stops at appropriate locations along with specials, expansion joints, contraction joints and construction joints, cover blocks and method of curing, methodology of repair of newly placed hardened concrete, testing and sampling of concrete during production and placement and acceptance checks for final clearance.

The equipment, deployment of manpower and machinery shall be arranged by the contractor to ensure the continuous rate of placement of specified grade of concrete so as to prevent segregation, bleeding, formation of cold joints, temperature control for concreting in extreme weather conditions and for mass concreting works,

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of placing concrete in case of ordinary Portland cement, not be less than 10 days for concrete exposed to dry and hot weather conditions, at least 10 days or period may be extended to 14 days where mineral admixtures or blended cements are used. Approved curing compounds may be used in lieu of moist curing with the permission of engineer-in-charge.

Reinforcement steel shall conform to relevant IS codes. Lapping / spacing of reinforcement shall be so staggered that under no circumstances more than 50% of bars at any cross section shall be lapped. Corrosion resistance Steel shall be used for the foundations wherever specified in the technical specification. Sample test for 3% of the number of mechanical bars grips subject to a minimum of three, shall be carried out up to the yield strength of reinforcement of bars.

Test shall be conducted for the water tightness of the liquid retaining structures as per technical specifications, IS 3370 and IS 6494.

All the materials, equipments, processes used in pre cast concrete work shall conform to the requirements for the cast-in-situ concrete.

If fly ash is used in concrete, source of supply shall be checked for suitability as per IS 3812 (Part-I). Routine tests for retention of particles on 45µ sieve and loss on ignition shall be carried out on each lot of fly ash before its use. The storage of fly ash shall be similar to that of cement. Separate Silo for fly ash shall be provided in the batching plant. Validation of Mix design using fly ash shall be carried out by an approved specialist agency, before start of concrete production.

The acceptance criteria of concrete shall be in accordance with clause no,16 of IS 456. However in exceptional circumstances and that too in non-critical areas, the engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS 456. For such accepted work, payment shall be made at a reduced rate pro rata to the concrete cube strength obtained, against that stipulated.

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to owner for their record and future reference.

a) Testing data/report of aggregates including petrographic examination & potential reactivity of aggregate and repeated temperature cycle tests wherever specified.

b) Mix design details and record of trial mixes carried out at site

c) Testing records of admixture as per IS-9103 / ASTM C494 including third party test reports.

d) Approved scheme for concreting

e) Hourly records of concreting including pour card

f) Protocol indicating the dimensional tolerance and details of inserts

g) Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used

h) Bar bending schedule.

i) Location and details of mechanical anchoring used for reinforcement.

j) Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings

k) Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification

l) Temperature control record of concrete at the time of placement if applicable.

m) Details of curing, staging and fixing / removal of formwork, checklist for formwork as per Clause 9.9 and Annexure-C of IS 14687 including all machine foundations.

n) Batching Plant shall be calibrated regularly at least once in a 3 months Computerized output shall be taken for each batch of production of concrete. For concreting works of ash pipe pedestals, mixer with weight batcher may be used. Production and supply of concrete from batching plant shall conform to the provisions of IS 4926.

o) Dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances for pre cast members as per OWNER Technical Specification. Load test on Pre cast members (except pre- cast tiles to be laid in the reservoir) shall be carried out @ 2% up to 1000 nos., @1% from more than 1000 nos. precast members of one type. The load test shall be carried out as per the provisions of IS-456

TOLERANCES			
Description of Item/ Structural Element		Max (mm)	Min (mm)
Cast In Situ Concrete			
1.	Faces of concrete in foundations and structural members against which back fill is placed	+25	-10
2.	Eccentricity of footing as percentage of footing width in the direction of placement	2% but limited to 50mm	
3.	Top surfaces of slabs and of concrete to receive base plates to be grouted	+5	-5
4.	Alignment of beams, lintels, columns, walls, slabs and similar structural elements	+5	-5
5.	Cross sectional dimensions of walls, slabs and similar structural elements	+5	-5

TOLERANCES				
Description of Item/ Structural Element			**Max (mm)**	**Min (mm)**
6.	Deviation from specified dimensions of cross-section of columns and beams		+12	-6
7.	Alignment of holding down bolts without sleeves		+1.5	-1.5
8.	Alignment of holding down bolts with sleeves		+5	-5
9.	Level of holding down bolt assemblies		+10	-10
10.	Embedded Parts (in any direction).		+5	-5
11.	Level of embedment for equipment support		+1.5	0
12.	Level of embedment for other embedded parts		+5	-5
13.	Centers of pockets or holes with greatest lateral dimension not exceeding 150mm		+10	-10
14.	Variation in steps • Riser • Tread		 +1.5 +3.0	 -1.5 -3.0
Pre- Cast Concrete				
15.	Length:	+/-0.1 percent	+/-5	+ 10
16.	Straightness or Bow	1/750 of the length	+/-5	+/-10
17.	Cross-sectional dimensions	+/- 3 mm or +/- 0.1 percent whichever is greater		
18.	Squareness:	When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.		
19.	Flatness :	The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.		

Placing of reinforcement and for cover	Clause 12.3.1 and 12.3.2 of IS 456
Formwork	Clause 9.6 of IS 14687 and 11.1 of IS 456
Batching	Clause 10.2.2 of IS 456

11.01.05 **Structural Steel Work**

For structural steel works provisions of technical specifications and IS: 800 shall apply. A detailed methodology for structural steel works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The contractor shall submit the welding procedures specification (WPS), heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection work at site. All welding and brazing shall be submitted to the OWNER and carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the OWNER.

All brazers, welders and welding operators employed on any part of the contract either in the contractor's / sub-contractor's works or at site or elsewhere shall be qualified as per AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the OWNER.

The records of welding procedure qualification and welder qualification test results shall be furnished to the OWNER for approval. However, where required by the OWNER, the tests shall be conducted in presence of OWNER / authorized representative.

No welding shall be carried out on cast iron components for repair. All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All Non-destructive examination shall be performed in accordance with written procedures as per International Standards and as mentioned elsewhere in the technical specification. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. The records of RT (Films) and UT (inspection records or printed reports if possible) shall be documented and produced to OWNER.

Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specification / approved WPS.

The requirements of pre-heating shall be

Thickness of thickest part at the area of welding/heat affected zone	Welding using other than low hydrogen welding electrodes IS-2062	Welding using tow hydrogen welding electrodes or submerged arc welding IS 2062
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	Not allowed	$20^{U}C$
Over 40 mm to 63 mm (including)	Not allowed	$66^{U}C$
Over 63 mm	Not allowed	$110^{U}C$

The following tests / checks shall be carried out for structural steel works

Sl. No.	**Tests / Checks**	**Quantum / Standard**
1.	Physical and chemical properties of material if supply in the scope of contractor	As per relevant codes, review of correlated mill test certificates or check testing in absence of MTC
2.	Ultrasonic test on plates above 40mm	As per ASTM A435
3.	Welding procedure & welders qualification test	AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards
Fillet Weld		
4.	Macro-etch examination on production test coupons for main fillet welds	Minimum one joint per built up beams, columns and crane girder etc.
5.	tension member of crane girder	Dye penetration test on 25% weld length
6.	All other fillet welds	DPT on 25% of the total length. Dye penetration test shall be carried out to the root run.

Sl. No.	Tests/Checks	Quantum/Standard
Butt Weld		
7.	DPT	100% after back gouging on ail butt welds except for coal bunker bins 10% after back gouging-For coal bunker bins 100% of the total length. Dye penetration test shall be carried out to the root run after back gouzing.
8.	Mechanical testing of production test coupons	Minimum one joint per built up beam, column and crane girder.
9.	Radiography test on butt welds (In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1. Wherever RT is not feasible UT to be carried out with the approval of the engineer)	100% RT on butt welds of tension flange (bottom flange) of crane girders 10% RT weld length of each welder on butt welds, except for crane girders and coal bunker 5% spot RT on butt welds / at inaccessible locations UT on butt welds- For coal bunker bins 100% radiography test shall be carried out for the plates of 32mm thick and above. 25% radiography test shall be carried out for the plates below 32mm thick. 100% radiography test shall be carried out of the crane girders and bunker girders irrespective of thickness of the plate.
10.	Ultrasonic testing on full penetration welds (other than butt welds)	100% UT on the web to flange joint of crane girder 10% UT on other full penetration joints
11.	Control assembly check in shop before erection	1st and further every 10th set of identical structure

Sl. No.	Tests /Checks	Quantum / Standard
12.	Dimensional tolerances during fabrication and erection	as per IS-7215 and IS-12843
13.	Surface Preparation and Paint thickness	SA 2.1/2 , By elcometer random after each coat, each member
CW Liners site fabrication (Field shop) test		
14.	WPS.PQR& welder's Qualification	100%
15.	DPT on root run	100% DPT for pipes upto 1200mm diameter
16.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
17.	UT	Not recommended.
18.	RT	5% RT
19.	DPT on finished butt welds	10% DPT
20.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher.
CW Liners erection site test		
21.	WPS.PQR& welder's Qualification	100%
22.	DPT on root run	100% DPT for pipes upto 1200mm diameter
23.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
24.	UT	Not recommended.
25.	RT	5% RT
26.	DPT on finished butt welds	10% DPT
27.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher. In cases where hydraulic test is not possible the same may be substituted with 100%RT
28.	Tolerances	As per approved drawings, as per IS : 7215 for fabrication and IS : 12843 for erection of steel structures

11.01.05.1 **Stoplog and Trash Racks**

Structural design shall be as per IS 5620 and IS 4622 and as per details given in technical specifications. The trash rack to be provided shall be Type-1 trash rack (removable section rack), conforming to IS: 11388 (latest). Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specification. The leakage measured shall not be more than 5 liters/ minute /meter of length of seal under maximum head. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the contractor as per the technical specification requirements. The contractor shall submit a manufacturing and field quality plans in OWNER format incorporating all the quality aspects mentioned in the technical specifications.

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS 13591 shall be referred for measurement of the deflection and acceptance criteria.

11.01.05.2 **Coal Tar Anti-Corrosion Tape**

Coal tar anti corrosion tape shall conform to the requirements of technical specifications. The Manufacturers test certificate for each lot of supply of the coal tar anti corrosion tape shall contain the softening point, needle penetration, filler content, breaking load in the longitudinal direction, service temperature, direct impact test, cathodic disbanding and solubility, in case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER.

Tests for Adhesion**,** holiday test and thickness shall be carried out at site**.**

11.01.06 **Painting Works**

Painting works shall be carried out as per the provisions of technical specifications. A detailed methodology for painting works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for painting works shall broadly contain the source of approved brand of paints, shot / sand blasting as specified, minimum acceptable size of shot used for blasting, application of primer, intermediate coat and final coat, experience of applicator, etc. testing of painting work and acceptance checks for final clearance. For PU coating works if specified, material shall be procured from OWNER approved source and the application of the PU coating shall be carried out by an experienced authorized applicator of the material supplier approved by OWNER. A separate quality plan and methodology for PU coating works shall be submitted by the contractor for

approval of OWNER. Based on the approved quality plan, the tests on material and works shall be got conducted at specialist laboratories like IICT Hyderabad, CECRI Karaikudi.

11.01.07 **Sheeting Works**

All bought out items shall be procured from the manufacturer's approved by engineer and tested as per relevant IS Codes/ Specification. Raw material of colour coated sheets shall meet the chemical & physical properties as per relevant standards / codes referred in the approved data sheet. It shall be tested for colour match, bare metal thickness, weight of Z/AZ coating, thickness of painting system, reverse impact, T-Bend adhesion, scratch resistance, salt spray test for 1000 Hrs. and any other test / properties as specified in the technical specifications. Colour coated sheets shall be marked with video jet printing at the interval not more than 2m bearing manufacturer's name, date and time of manufacturing. Fasteners shall also be tested for 1000 hrs salt spray test as per the requirement of technical specifications.

Bonded Mineral Wool Insulation shall meet the requirements of thickness, density, thermal Conductivity, all other tests as per the technical specifications and IS-8183.

For sheet installation no gas cut opening shall be allowed at the site, whenever opening is specified these shall be properly cut in the factory and shall be filled with lipping / flashing for true shape / dimension etc. The sheets/ packets shall be stacked neatly clear off the ground at an angle to the ground, over a base pallet to provide drainage. Water / moisture should not be allowed to stagnate on surface, or in between layers. This can damage the coating, and cause corrosion.

11.01.08 **Tile Works**

The execution, finishing, testing and acceptance of tile works shall be as per the provisions of technical specifications. The material for tile works shall be procured from the OWNER approved brand / source**.** Local depressions on account of faulty workmanship, tiles / natural stones with cracked or broken / chipped edges shall not be acceptable.

The tests shall be carried out on acid resistant bricks / tile- water absorption, compressive strength, resistance to acid, flexural strength, dimensions and all other tests as per IS 4860 and IS 4457, bitumastic ready mixed paint as per IS 158, bitumastic as per IS 9510, potassium silicate, resin type and sulphur type mortars as per IS 4832, part I, II and III, surface preparation for painting as per IS 2395, epoxy painting shall be carried for required coating thickness and dry film thickness.

11.01.09 **Fire Proof Doors**

Fire Proof doors shall be tested for the requirements mentioned in the Technical Specification. The type test of the doors shall be carried out at CBRI Roorkee for minimum 2 hours fire rating and its Fabrication drawing shall also be approved by CBRI, Roorkee. DFT of paint of Fire Proof Doors and its fittings and fixtures as per BOQ shall be checked. The doors shall be finished with suitable fire retardant painting system

11.01.10 **Water Proofing**

The execution, finishing, testing and acceptance of water proofing works shall be as per the provisions of technical specifications. The material for the works shall be procured from the OWNER approved brand / source and the works shall be executed by the authorized applicator of the supplier.

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel / drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and wall junctions etc. which have been subjected for testing. The above testing shall be earned out prior to application of wearing course.

11.01.11 **Piling Work**

For piling works provisions of technical specifications, approved drawings, BOQs and relevant IS codes / standards shall apply. The piling works shall be executed by the agency meeting the qualifying requirements as specified. A detailed methodology for piling works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for piling works shall broadly contain the method of boring, stability of bore hole, termination criteria, tests / checks for termination level, fabrication of cage, cage lowering, concrete batching / mixing, transportation, placing, recording of the time of construction operations, method of conducting initial and routine load tests, testing and sampling of concrete during production and placement and acceptance checks on piles for final clearance.

The equipment, deployment of manpower and machinery shall be arrangement by the contractor to prevent the collapse of bore hole and to ensure continuous rate of placement of specified grade of concrete.

The piling works shall be executed as per the technical specifications, approved drawings, relevant codes / standards, FQP and BOQ. In addition to the requirements of technical specifications, the following shall also be ensured while execution of piling works :

a) Time gap between completion of pile boring and start of concreting should be kept to the minimum. However the maximum time gap shall not be more than 6 hours.

b) Muck Debris should be removed from the pile bore by air lift technique(by keeping the tremie & air pipe as close as to bottom of pile bore) i.e. after completion of boring, after completion of SPT(wherever applicable), after lowering reinforcement cage, but before start of concreting.

c) Density of bentonite slurry shall be checked from the sample taken from the bottom of pile bore (not at 1.0 m above the bottom of the pile bore)

d) Minimum two welding sets shall be kept ready to join the two cages of reinforcement by engaging 3 or more welders. This will ensure the lowering of R/F cage in minimum time.

e) While lowering the R/F cage into the pile bore, two hooks shall always be used to ensure balanced/symmetrical insertion of cage into the pile bore.

f) Concrete cover blocks at the junction of two R/F cage shall be ensured before lowering the second segment.

g) Surge concreting of about 1.0 cum shall be ensured at the start of concreting (i.e. in the first pour), by suddenly allowing to fall through the tremie pipe from the funnel. This will help in displacing left out muck/debris in the pile bore (by the impact).

h) Continuous feeding of concrete shall be ensured by deploying at least two transit concrete mixers (if required to be deployed) and mixing done through concrete batching plant (if deployed). Cold joints in the pile shall be avoided.

i) In a pile group, SPT shall be carried out at termination level in the pile, taken up first.

j) Bentonite slurry circulation to be ensured from start of boring to start of concreting. Flushing of bentonite slurry will only ensure maintaining of density of bentonite slurry uniformly and will not allow bentonite jelly to settle at the bottom, whereas air lift technique with bentonite circulation will ensure removal of muck debris from the bottom of pile bore.

k) Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, minimum once per week or as found necessary by the engineer. One sample consisting of 3 specimens shall be tested for the above.

l) Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Technical Specification. This test shall be suitably used to identify the piles for routine tests. High Strain dynamic test shall be done as per the technical specification. The frequency of the test shall be as per the BOQ

m) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

Pile Load Test

Pile load testing shall conform to the requirements of IS-2911 (Part IV) and the technical specification. Initial load tests as specified in the contract documents shall be conducted to assess the safe load carrying capacity of pile before start of work. To verify the load carrying capacity of the working piles, routine load test shall be conducted.

Pile load-testing procedure and the test setup / scheme shall be submitted for approval of OWNER. The contractor shall use the test setup having arrangement for anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge for both vertical compression and uplift (tension) Load test (initial) on piles. The cost of reaction system / piles shall deem *to* be included in the cost of test piles

All the gauges and instruments shall be calibrated before the start of the tests on test piles and working piles and the calibration record shall be verified before start of execution of the test.

11.01.12 **Water Supply, Drainage & Sanitation**

Material used for sanitary and plumbing fittings and fixtures shall conform to and be tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

The obstructions in sewer lines shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked 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 the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

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 test / working condition of pressure and flow, when all draw-off taps are closed. The service pipes shall be checked for satisfactory support and protection from damage, corrosion and frost.

11.01.13 Architectural & Misc. Works

Material used for sanitary and plumbing fittings and fixtures, floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

Fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. shall be checked for correctness of locations and smoothness of operation and fixtures. All controls and locking devices shall give fault free performance. 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 2.5 mm.

Materials used in glass and glazing shall be procured from source approved by OWNER and shall conform to the requirements of the Technical Specification and IS Codes.

False ceiling panels shall be best quality material in thickness and properties called for in the specification / schedule of items. Material Test Certificate to be submitted before bulk supply.

All bought items covered in the scope of contract shall be procured from sources approved by OWNER and shall conform to the requirements of the technical specifications and referred standards / codes.

11.01.14 Road Work

Quality Assurance and testing requirements for roadwork shall be as per the MOSRTH-Specification (Section 900), IRC specifications or CPWD specifications as specified in the technical specifications and BOQ of the contract.

The testing and sampling shall include the checks on earth work for embankment and subgrade, sub bases and bases and bituminous constructions. The sampling and testing of concrete pavements shall be as per the respective items of earthwork, subgrade / sub-base, concrete, etc.

11.01.15 Fabric Expansion Compensator

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstandability test.

Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS:8183.

Tests and checks on all other items shall be carried out as per relevant codes.

11.01.16 QA Requirements for Slip form Shuttering

1. The monitoring of the leveling of the yoke and the platform of the slip form shuttering to be done in each shift to avoid tilt during the casting of the chimney shell.

2. Manning of each shift shall be done by at least two experienced operators and a foreman particularly in night shift.

3. Suitable removal/ reduction of overhung / excess yoke beam length shall be affected with the decrease in the diameter of Chimney shell, as per the approved plan.

4. The laser centering method to be deployed for chimney alignment and Monitoring of chimney centre should be done by laser instruments at least two points. Monitoring/Recording of the same shall be done in each shift of 8 hours

5. Shuttering plates to be used for slip form shall be new and the grade of steel shall conform to the specification requirements.

6. The outage of the alignment of chimney centre shall be prevented by creating a counterbalance for alignment purpose to avoid differential loading, arising out of placement of reinforcement bars at one side or unloading of concrete in a hopper at one side of the platform for slip form shuttering.

11.01.17 QA Requirements for Dyke Work/Impervious Soil Fill/ Other Fill Works

The suitability of the fill materials from each source using laboratory/ field tests shall be determined / ascertained by the contractor prior to start of filling work and shall be approved by Engineer. The fill material free from shingle, salts, organic matters, roots sod or any other foreign substances shall be used for filling.

11.01.17.1 Embankment Filling

The fill materials shall be free from debris, wood, vegetable matter and other deleterious matter. Control tests shall be carried out in laboratory from time to time to determine whether the fill produced by methods employed satisfies the requirements of the specifications. Routine field tests shall also be carried out by the Engineer and the work shall be inspected regularly. Field density test should be particularly and specially made in the following areas:

a) Where the degree of compaction is doubtful.

b) Where embankment operations are concentrated i.e. where 2 or more layers are placed one over the other on the same day.

c) To represent every 2000 cum in case of earth and/or 1000 cum in case of ash placed in the embankment.

d) Atleast one test for every full or part shift of compaction operations and

e) Atleast one test for every 250 m length of dyke in each layer. The Engineer shall determine whether the desired results are being obtained.

QA&QC test for Embankment Filling shall be carried out in line with the Technical Specification, PART-B.

11.01.17.2 **Impervious Soil Filling**

The suitability of the material from each source shall be determined by laboratory tests and shall be approved by Engineer. QA&QC test for Impervious Soil Filling shall be carried out in line with the Technical Specification, PART-B. The spreading of the next layer shall be carried out only after the underlying layer has been approved by the Engineer or his authorized representative.

11.01.17.3 **Sand Blanket, Chimney And Filter**

The material for blanket, chimney and sand filters shall consist of clean sound and well graded coarse sand. The materials shall be free from debris, wood, vegetable matter and other deleterious matter. The gradation of sand material shall meet the requirements as specified. QA&QC test for Sand Blanket, Chimney and Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.4 **Graded Coarse Aggregate Filter**

The coarse aggregate material shall consist of durable well graded broken rock of hard stone variety from the specified quarries and shall be approved prior to being transported to the area of deposition. The materials shall range in the size from 10 mm to 75 mm and shall satisfy the specified filter criteria. QA&QC test for Graded Coarse Aggregate Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.5 **Rock-Toe, Rip-Rap Works, Rr Masonary**

Rock toe shall be formed with rock material consisting of sound, durable and well-graded broken rock obtained from approved quarries and shall be of approved quality. The materials shall range in size from 10 to 45 cm. QA&QC test for rock-toe, rip-rap works hall be carried out in line with the Technical Specification, PART-B.

11.01.17.6 **Slope Protection Works**

Slope protection works with dry brick packing or ash-cement/ soil-cement mortar ash cement concrete on the slopes, confined within brick masonry panel walls shall be constructed with approved quality of materials. Slope protection works with turfing on downstream slope shall be as per IRC standards. Slope protection works with ash cement concrete on the downstream slopes shall be constructed with approved quality of materials. QA&QC tests for slope protection works shall be carried out in line with the Technical Specification, PART-B.

11.01.17.7 **Bentonite Liner**

Construction Quality Control (CQC) tests as indicated in Table shall be performed by the Contractor's Quality Control Team at regular intervals upon completion of the Soil-Bentonite liner.

QCQ Requirements for Impervious Liner

Parameter	**Test Frequency per layer**
Moisture Content	1 per 5,000 Cum
Field Density	1 per 5,000 Cum
Falling Head Permeability	1 per 25,000 Cum

All CQC test results shall achieve the required values as established by the engineer. Failure to achieve these values shall require re-working of the Impervious mixture in the failed areas.

12.00.00 **SHOP TEST EOT CRANES, OTHER CRANES & HOIST**

1.0 **Hooks**

1.1 All tests including proof load test as per relevant IS/BS/DtN shall be carried out.

1.2 MPI/DPT shall be carried out after proof load test.

2.0 **Steel Casting**

2.1 DPT on machined surface shall be carried out.

3.0 Girders, end carriage.crab, gear box and rope drum

3.1 The plates of thickness 25mm and above shall be ultrasonically tested.

3.2 NDT requirements on weldments shall be as follows:

a)	BUTT WELDS IN TENSION	:	100% RT AND 100% DPT
b)	BUTT WELDS IN COMPRESSION	:	10% RT AND 100% DPT
c)	BUTT WELDS IN ROPE DRUM	:	100% RT AND 100% DPT
d)	FILLET WELDS	:	RANDOM 10% DPT

4.0 Forging (Wheel, Gears, Pinions, Axle, Hooks & Hook Trunion)

4.1 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing.

4.2 DPT/MPI shall be done after hardfacing and machining.

5.0 Wire rope shall be tested as per relevant standard.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. gear box shall be subjected to no-load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. all tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per is-3177 shall be carried out at shop.

8.0 All electric hoists shall be tested as per is-3938 and chain pulley blocks shall be tested as per is-3832.

13.00.00 **CATHODIC PROTECTION**

Quality of cathodic protection system shall be as per given table.

IMPRESSED CURRENT CATHODIC PROTECTION

Transformer Rectifier Unit

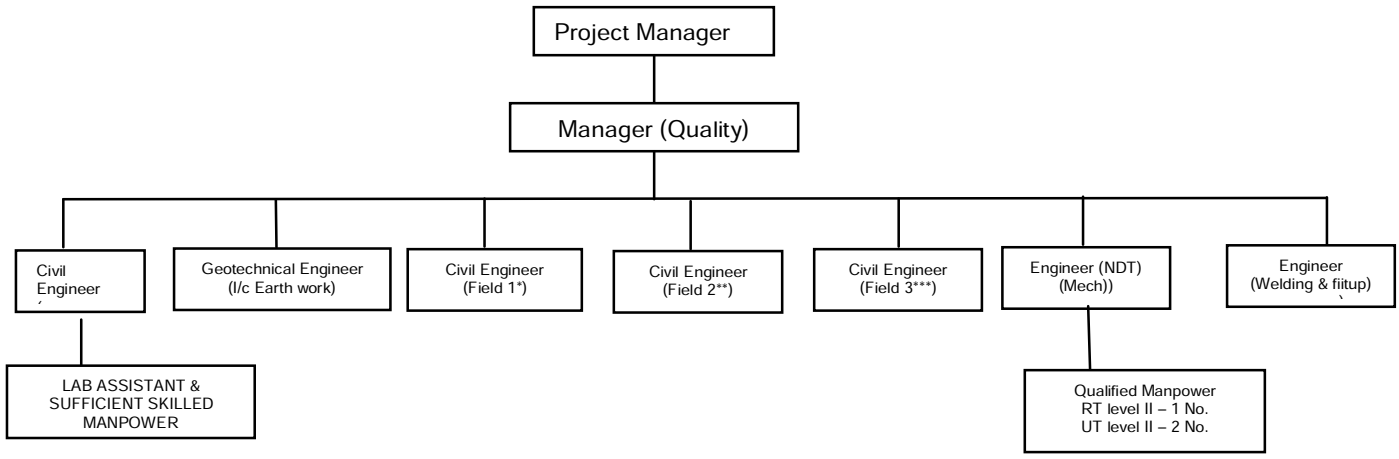
Attributes Characteristics → / Items / Components / Sub-assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Operational & Functional Checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of TRU as per OWNER specification	Efficiency Test on TRU & Transformer	Heat Run Test	Ratio & Polarity Test on TRU	HV & IR Test
Rectifier Transformer (IS : 2026)	Y				Y			Y			Y
Electronic Components	Y				Y						
PCB & Electronic Cards	Y				Y						
Control & Selector Switches (IS : 6875)	Y			Y	Y						
Indicating Meters (IS : 1248)	Y			Y	Y						
Indicating Lamps (IS : 13947)	Y			Y	Y						
Air Break Switches / Fuses (IS : 13947/13703)	Y			Y	Y						
Control Terminal Blocks (IS : 13947)	Y				Y						
Control Transformer (IS : 12021)	Y			Y	Y						
Push Buttons (IS : 4794)	Y			Y	Y						
MCB (IS : 8828)	Y			Y	Y						
PVC insulated Copper control wires (IS : 694)	Y				Y						
Sheet Steel (IS : 513)	Y	Y	Y		Y						
Synthetic Rubber Gaskets	Y	Y			Y						
Annunciator	Y			Y							
Transformer Rectifier Unit	Y					Y	Y	Y	Y	Y	Y

Notes

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Makes of all major Bought Out Items will be subject to OWNER approval.

QA & QC ORGANISATION SETUP



NOTE :

1. The above organization setup is minimum however their deployment shall be as per the agreed deployment schedule. The contractor shall prepare a manpower deployment schedule in line with the finalized work plan and the same shall be submitted to the engineer-in charge for acceptance/ approval.

2. The contractor shall mobilize the QA& QC manpower in line with the finalized manpower deployment schedule and shall ensure their availability well in advance (15 days approx.) of the beginning of the concerned activity/ work.

3. The contractor shall further mobilize required number of skilled & supporting staff and additional resources, if any to meet the work schedule.

4. For concrete work 2 Nos. (one for foundation work & one for superstructure)

5. ** For lines and levels -1 No.

6. *** For Finishes and cladding work -1 No

VOLUME : VII-C

SECTION-XVI

TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORK

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XVI : 1
2.00.00	INSTALLATION	VII-C/S-XVI : 1
3.00.00	RATES	VII-C/S-XVI : 7
4.00.00	METHOD OF MEASUREMENT	VII-C/S-XVI : 7
5.00.00	I. S. CODES	VII-C/S-XVI : 9

VOLUME : VII-C

SECTION-XVI

TECHNICAL SPECIFICATION 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 Soling

2.01.01 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 lying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 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.

2.02.00 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.

2.03.00 Masonry

2.03.01 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.

2.03.02 Mortar

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

Lime shall not be used where reinforcement is provided in brick work.

2.03.03 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. The bricks required for masonry work using mud mortar shall not be soaked. 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.

2.03.04 **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 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 in the Schedule of Item, 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.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified in the Schedule of Items. 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.

2.03.06 **Cavity Wall**

It is wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50mm and not more than 115mm. Each leaf of the cavity wall shall not be less than 75mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

2.03.06.01 **Metal Ties**

These may be of galvanized iron, wrought iron, gun metal, brass, copper, stainless steel or ant such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

2.03.06.02 **Bonding Units**

These shall be preferably precast R.C.C. units.

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves plus width of cavity if the leaves are 75mm or 115mm. If the leaves are more than 115mm thick, then the length of a unit will be 2x115+width of cavity. Precast RCC units shall be provided with 2 no. , 6mm mild steel reinforcement bars tied with 2 no. 3 mm. dia. wire/hard drawn wire cross bars placed in the centre of units.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1cement: 3coarse sand: 6 graded stone aggregate 20mm nominal size)

2.03.06.03 **Spacing**

Metal ties/bonding units shall be spaced not more than 90cm apart horizontally and 45cm vertically and staggered in each course. Additional ties shall be used near openings.

2.03.06.04 **Restrictions**

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

2.03.07 **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. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.08 **Exposed Stonework**

Stonework, which is to be kept exposed, shall be as shown on drawing or described in the Schedule of Items. Especially especially skilled mason shall execute it. 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 the Schedule of Items or instructions. A sample wall, 10sq.m. In area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 **Hollow and Solid concrete block Masonry**

Hollow and solid concrete block shall conform to the requirement of I.S 2185. Hollow concrete block shall be sound, free from broken edges; free from cracks, honeycombing and other defects, which may give a defective work, impaired the required strength.

Dimensional stability: concrete masonry units shall be made of proper sizes and shape to suit the construction need and shall be in neutral of the following sizes:

The nominal size of concrete block /solid concrete block.

Length : 400,500,600.

Height : 200,100

Width : 50, 75,100,150,200,250,300.

In addition block shall be manufactured in half-length of correspondence to full length. Maximum tolerance of length shall be (±) 5mm and in height &with shall be ± 3mm.

The average crushing strength shall be determined as per I.S 2185 and shall be of Load bearing wall density of block shall be not less than 1500 kg /mm^3 and minimum average compressive strength of units shall be 3.5 to 7 N/mm^3 and minimum strength of individual unit shall be 2.8 to 5.6 for block density less than 1500 kg /mm^3 but not less than 1000 kg /mm^3 average compressive strength of units shall be 2.0 to5 N/mm^3 and minimum strength of individual unit shall be 1.6 to 4.0 N/mm^3

For non load bearing wall block density shall be not less than 1000kg / mm^3 and minimum average compressive strength of units shall be1.5 N/mm^3 and minimum strength shall be 1.2 N/mm^3

2.03.08 **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.

2.03.09 **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 in the Schedule of Items. 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.

2.03.10 **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.

2.03.11 **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.

2.03.12 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.03.13 **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.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatments as specified in IS: 1609. The number of courses shall be as mentioned in the Schedule of Items. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after lying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **RATES**

Rates shall be unit rates for the complete work as detailed out in the Specification unless any particular portion is specifically excluded in the Schedule of Items.

4.00.00 **METHOD OF MEASUREMENT**

4.01.00 **Soling**

Soling of different types as enumerated in the Schedule of Items shall be measured on actual area basis. Deductions shall not be made for areas less than 0.1 Sq.M.

4.02.00 **Brick Edging**

Edging shall be measured on running length unless included in other relevant items.

4.03.00 **Masonry**

4.03.01 Thickness of brick walls shall be measured in nominal brick sizes.

4.03.02 For masonry work exceeding 150 mm in thickness, actual volume of work shall be measured and deductions for openings, lintels, sills, conduit ducts, pipes etc. shall be made. No opening less than 0.1 Sq.M. in area shall however be deducted.

4.03.03 No deductions shall be made for embedded fixtures nor any extra be paid for the mortar used for fixing or for necessary cutting of bricks.

4.03.04 For encasing of steel beams, columns etc. The sizes as shown on drawings shall be measured and deductions made for the volume of encased steel.

4.03.05 No extra payment shall be made for cutting of masonry units.

4.03.06 Walls 150 mm in thickness or less shall be measured for actual area of works and deductions made as in Clause 5.1.4.3.2.

4.03.07 Exposed brickwork using selected ordinary brick or face bricks for the exposed face shall be measured in area as an extra over the ordinary brickwork if so provided in the Schedule of Items. It shall be measured by volume including the composite backing if so provided in the Schedule. Deductions shall be made as described in Clause 5.1.4.3.2.

4.03.08 Reinforcements shall be measured and paid separately under relevant items in the schedule unless included in the items for masonry work.

Laps in wire mesh reinforcements shall not be measured. Reinforcing mesh shall be measured on actual area basis. Reinforcing bars shall be measured by weight.

The weight shall be arrived at on the basis of sectional weights as per I.S. No extra shall be paid for necessary modifications of existing dowels, if any, to tie up with the Contractor's work.

4.03.09 **Exposed Stonework**

Exposed Stonework using selected stone for exposed face shall be measured in area as an extra over ordinary stonework if so provided in the Schedule of Items. Deductions shall be made as described in Clause 5.1.4.3.2.

4.03.10 **Composite Masonry**

Composite masonry shall be measured for volume including backing if so provided in the Schedule of Items. If not, brickwork and stonework shall be measured separately and paid under relevant items.

4.03.11 **Expansion and Separation Joints**

Joints shall be measured for length or area for the complete work as shown on drawings including filler boards, sealant strips, sealing compounds, painting, cover etc. If so provided in the Schedule of Items unless any particular work is specifically excluded from the item.

4.03.12 **Mouldings, Cornice, Drip Course**

Mouldings, cornice, drip course unless indicated specifically under separate items shall be considered to be included in masonry items. However, cut in bricks or stone shall be neglected in measurements.

4.03.13 **Embedded Fixtures**

Inserts etc. Shall be measured by weight or by number and paid separately under relevant item in the Schedule of Items.

4.04.00 **Damp Proofing**

Damp proofing shall be measured and paid in net area. No deductions shall however be made for openings less than 0.1 sq. M. in area. No separate payment shall be made for preparation of base, formworks and additive for cast-in-situ damp proofing unless specified otherwise.

5.00.00 **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.

VOLUME : VII-C

SECTION-XVII

TECHNICAL SPECIFICATION
FOR
FINISH TO MASONRY AND CONCRETE

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XVII : 1
2.00.00	INSTALLATION	VII-C/S-XVII : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XVII : 17
4.00.00	RATES	VII-C/S-XVII : 17
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XVII : 18
6.00.00	I. S. CODES	VII-C/S-XVII : 18

VOLUME : VII-C

SECTION-XVII

TECHNICAL SPECIFICATION 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 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.

2.00.00 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 are 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.

2.01.00 Preparation of Surface

The cement plaster shall be 6 mm, 12mm, 15mm, 18mm or 20mm as specified in the item.

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 Schedule of Items.

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.

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **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 without any extra payment. 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 per description of the item is 20mm the average thickness of the plaster shall not be less than 20mm weather 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 suitable protected from all damages at the contractor'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 contractor shall provide chicken mesh to hold the plaster, at his own cost.

Deductions in measurements, for opening etc. will regulated as Follows :

a) No deduction will be made for openings or ends of joints, beams, posts, girders, steps etc. up to 0.5 sqm in areas and no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.

b) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, jambs, soffits sills, sills, etc. of these openings.

i) When both faces of walls are plastered with same plaster,

ii) Deductions shall be made for one face only.

iii) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is unplastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side.

iv) Where width of reveals on both faces of wall is equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.

v) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

c) For opening exceeding 3 sqm area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

Cement Plaster with a Floating coat of Neat Cement

The cement plaster shall be 12, 15, or 20mm thick, finished with a floating coat of neat cement, as described in the item.

Specifications for this item of work shall be same as describe 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 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 6mm finishing coat and shall have an average total thickness of not less than 18mm.

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.

6mm 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.

6mm 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

Deductions

Deduction shall not be made for openings or for ends of columns, or columns caps of 0.5sqm each in area and under. No additions will be made either for the plastering of the sides of such openings. For openings etc. of areas exceeding 0.5 sqm deduction will be made for the full opening but the sides of such openings shall be measured for payment

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 rubbed smooth with a trowel.

c) **Coloured Plaster Finish**

This shall be done in the same way as specified in clause 6.1.2.2.2 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 edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (In Situ Work)**

The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6.3mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

Specification for scaffolding, preparation of surface and mortar shall be as described earlier.

e) **Rough-Cast Finish**

Rough cast finish comprises of a mixture of sand and gravel in specified proportions dashed over a freshly plastered surface.

Preparation of surface

The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

Mortar

Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5mm

Application

The plaster base over which roughcast finish is to be applied shall consist of two coats, under layer 12mm thick and top layer 10mm.

12mm Under Layer

This shall be applied in the same manner as specified in earlier under 18mm cement plaster except that the finishing, after the mortar has been brought to a level with the wooden straight edge, shall be done with wooden float only.

Top Layer

The top layer shall be applied a day or two after the under layer has taken initial set. The latter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1: 3 (1 cement: 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

Finish

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5mm or as specified and in the proportions as specified accurately to the effect required. The mixture gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-charge.

Specification for other details like precautions etc. as described earlier.

f) **Scraped Finish**

Ordinary plaster as described under Clause 6.1.2.2.2 after being levelled 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 6.1.2.2.2. 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) **External Quality Glass Mosaic Tiles**

Glass mosaic tiles to be laid in pattern and profiles on a bed of cement mortar 1:3 (with coarse sand) and set in cement paste or adhesive of approved quality & make, joints filled and finished by neat in pigmented cement or sealant of approved quality & brand and cured including necessary adjustment at edges corners etc. complete, strictly as per the manufacturer's specification & details. in walls, ceiling, soffits up to all elevations in straight or curved surface as murals or wall claddings per drawing & instruction of the Engineer-in-charge.

The following important steps to be followed for installation of "Glass Mosaic" tiles

Preparing the surface

The surface to be tiled must be clean, smooth and clean of dust. It must be in plumb and should be dry.

Application of adhesive

A good quality Latex-Modified thinest to be applied as approved by Engineer-in-charge for fixing of mosaic tiles. Thinset should be compatible with the substrate and environment (i.e. wet areas or exterior areas). The adhesive should be thick enough to avoid mosaic sheets from slipping once placed on the wall. Spread the adhesive uniformly (about 3mm thick) on the wall using the straight edge of the trowel. With the toothed edge of the trowel, comb the adhesive through.

Installation mosaic mounted on paper

Mosaic sheets with the paper side to be faced up. After pressing the sheets firmly in one direction, rubbers float to be used to tap the sheets. A wooden float may also be used but never a metal one. It is to check that all sheets are placed at the exact same distance from each other as the tiles.

After the mosaics have started to set, but before they become fully bonded the paper the paper should be removed. A damp sponge to be used on the surface of the sheets to ensure easy removal of the paper. Paper to be removed carefully by pulling one corner of the paper diagonally across the sheet. This must be done gently to ensure that no tiles are dislodged in the process. Realign any tiles with a spatula and remove excess adhesive at this point. Let the adhesive dry for approximately 24 hrs before beginning the grouting process.

Installation of mosaic mounted on mesh

Mosaic sheets with the mesh backing to be installed by pressing directly on the adhesive. A rubber or wooden float to be used to tap the sheets to ensure a flat and even surface. It is to check that all sheets are placed at the exact same distance from each other as the tiles. Adhesive to be applied as much as possible so that it can be covered with in 10 to 20 minutes or until surface is still wet and tacky. Tiles to be allowed to set until firm. Clean excess adhesive from the surface of the tile to set firm. Clean excess adhesive from the surface of the tile with wet cloth or sponge while the setting material is fresh. Leave the surface to dry before beginning the grouting process.

Grouting

Sponge & warm water to be used to remove any excess adhesive on the sheets. The surface must be free from dust. Using a hard rubber float, spread the grout horizontally and vertically on the mosaic sheet. Cover an area of not more than 2 sq mtr. at a time. Excess grout to be removed with the rubber float by working diagonally across the mosaics. After grouting, wait approximately 20 minutes before cleaning the excess grout.

Material specification

Glass mosaic tiles to be either gloss or mat finish quality with the size 20x20mm to 25x25mm, weight 7.5 kg to 8.7 kg per sqm, thickness 3.8 to 4.5mm, water absorption < 0.1%. It should have excellent stain resistant, UV resistant, frost resistant, thermal shock resistant and chemical resistant property. Size and type of tiles (Gloss or matt finish) to be as per drawing and approval of the Engineer-in-charge.

i) **1st Quality Ceramic Glazed External Wall Tiles**

Ceramic exterior wall tiles of work size 150 x 300mm (textured surface) with thickness varies from 8.5mm to 10mm on a single tile due to 3D surface, applicable only for wet cladding. It should conform to ISO 13006 / EN 159 Group B III. The linear thermal expansion of tiles should be 9 X $10^{-6}K^{-1}$, Max.

Application

Surfaces to be tiled must be dry, clean and free from all contamination and should be dried and cured for at least two weeks.

The adhesive should be added to clean water and mixed thoroughly until a slump-free mortar is obtained. The adhesive is immediately ready – for- use and has a pot life of 3 hours. No further water should be added.

1. Spread not more than 1 sq.m. at a time , apply the adhesive to the wall surface.

2. Comb the adhesive to the required depth (between 3-6 mm) using a suitable trowel.

3. Press the tiles firmly into position with a slight twisting action, checking periodically that good contact is maintained with the back of each tile. Leave no voids behind the tiles when solid-bed fixing.

4. Tiles should be fixed within 20 minutes of the adhesive being applied, depending on the porosity of the surface and atmospheric conditions. Tiles can be adjusted up to 5-10 mins. after fixing.

5. Leave adequate joints (2-3 mm) between individual wall tiles by using spacer & to be grouted with polymer grout. This has to be maintained to avoid expansion – contraction problem due to climatic change as it will be exposed to sun.

6. Clean off surplus adhesive from the tile face and between joints.

7. Do not use in damp conditions.

8. Grouting should not be carried out for at least 24 hours.

j) **Heritage Granular Finish Work**

Heritage granular finish should be with special silica sand coloured wide inorganic pigments along with acrylic co-polymer bonding agent containing biocides / fungicides and stabilizing adhesive. Application thickness will be 0.8mm to 1.2 mm as per JISA 6909.

The application to be done on plastered surface at all elevations as per design, drawing, manufacturers specification and direction of Engineer-in-charge, complete in all respect

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 with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called for in the Schedule of Items, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 **Lime Punning**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The 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. area 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 and/or schedule of items. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings and/or Schedule of Items.

2.08.00 **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.

2.09.00 **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 contractor 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.

The rate shall include the cost of all labour and materials involved in all the operations described above.

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 **RATES**

Rates shall be for the complete work as detailed out in the specification unless any particular portion is specifically excluded in the Schedule of Items.

5.00.00 METHOD OF MEASUREMENT

a) All surface finish shall be measured on actual area laid. No deductions shall be made for openings, pipes, and sleeves etc. upto 0.1 Sq.M. in area.

b) Unless separate item is provided for special corner or edge finish, drip course, grooves, mouldings, curbs etc. these shall not be measured separately. Where separate item is provided in the Schedule of Items, such work shall be measured for length.

c) No separate payment shall be made for finishing round openings, sleeves, pipes, etc. No separate payment shall be made for formwork, templates etc. required for achieving true lines and profiles as shown on drawing.

d) Finishes applied integrally with walls, floors, steps and ceilings shall be measured separately and paid under relevant items.

e) Any reinforcement incorporated in the finish shall be measured and paid separately under relevant items.

f) Unless otherwise mentioned in the Schedule of Items, hangers, supports and laths for lath plastering shall be measured and paid separately under relevant items.

6.00.00 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

VOLUME : VII-C

SECTION-XVIII

TECHNICAL SPECIFICATION
FOR
SINGLE AND SANDWICH METAL CLADDING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	GENERAL	VII-C/S-XVIII : 1
2.00.00	PRODUCTS	VII-C/S-XVIII : 3
3.00.00	DOUBLE SKIN INSULATED METAL CLADDING	VII-C/S-XVIII : 4
4.00.00	EXECUTION	VII-C/S-XVIII : 5
5.00.00	RATES	VII-C/S-XVIII : 6
6.00.00	METHOD OF MEASUREMENT	VII-C/S-XVIII : 6

VOLUME : VII-C

SECTION-XVIII

TECHNICAL SPECIFICATION FOR SINGLE AND SANDWICH METAL CLADDING

1.00.00 **GENERAL**

1.01.00 **Description**

1.01.01 This section covers, providing, furnishing and installation of sandwich/double skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes, conductors etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 **Applicable Codes and Standards**

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/owner's approval.

1.02.02 ASTM - American Society for Testing Materials.

1.02.02.1 A446 - Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 - Steel, cold rolled sheet.

1.03.00 **Submittals**

1.03.01 The contractor shall submit to the owner the following items for review before commencing work.

1.03.01.1 **Samples**

a) Three 300 x 300 mm pieces of each type of pre-coated and preformed metal sheet for top skin and bottom skin.

b) Type of insulation proposed for use and its thickness and density.

c) Fabricated sandwich metal cladding- Sample size shall be 300 x 300 mm three nos.

d) Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 **Shop Drawings**

Showing fabrication details of sandwich/double skin metal cladding with Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 **Test Reports**

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 **Supplier Certificates**

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 **Product Handling**

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 **PRODUCTS**

2.01.00 **General**

2.01.01 All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation shall have a minimum R-value of 2.083 M^2 ^oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 **Material**

2.01.04.1	Base Material	High tensile steel
2.01.04.2	Metal protection	Galvalume
2.01.04.3	Organic coating	Silicon Modified Polyester (SMP) Fluoro polymer (PVF_2) and plastisols to resist aggressive climate of the jobsite

2.01.05 Material shall be prefabricated sandwich panel with polystyrene insulation/high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm or as recommended by manufacturer to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg / M^3 for polystyrene and shall have minimum R-value 2.083 M^2 ^oK/Watt.

2.01.07 Panel size shall be largest available size.

2.01.08 Warranty for precoated profiled metal sandwich /double skin cladding shall be for a minimum period of 40 years.

2.01.09 **Sealants**

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01.10 Profile HDPE Filler

2.01.10.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

2.01.10.2 Metal flashing shall be of similar material and colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between. External sheet shall be of interlocking type.

3.01.02 Providing, erecting, fitting & fixing at all elevations double skin insulated roofing / wall cladding with Luxalon or equivalent 150 F and profiled steel sheets made out of 0.55mm (TCT) permanently colour-coated galvalume steel (150gsm Zinc Aluminium alloy coating total of both as per AS 1397:1993) having 550 MPa yield strength. Colour coating shall comprise of Polyester coating of approved colour. The Polyester colour coating shall comprise of 15-20 micron finished coat over 5 micron primer coat on the exposed side and manufacturer's back coat of 5 microns over a primer coat on the inner side.

The external sheet shall be Luxalon or equivalent 150 F fixed on to the hat sections with the help of specially designed carriers to hold the external Luxalon cladding. The inner sheet shall have 980mm cover width, 28mm high crest at 195mm c/c. with special male / female side-laps and anti-siphoning features to prevent leakage. Two small ribs are there in between the two profiles. The inner sheet along with sub-girths of size 50mm x 50mm x 50mm manufactured out of 1.6mm GI sheet in 'C' / 'Z' shape would be fixed to the purlin by means of self-drilling fasteners (12G - 14TPI x required length). Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer-head Zinc-coated self-drilling fasteners / screws on to the sub-girths. The clips shall be concealed and no fasteners are to penetrate the external sheeting.

An insulation of 50mm thick Rockloyd Resin-bonded Rockwool of density 48 kg./m3 conforming to IS:8183 shall be provided and fixed between two sheets.

3..01.03 Providing and fixing of double skin prefabricated factory assembled rock wool insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 550 Mpa yield strength. The colour coating shall comprise of SMP / super polyester PVF2. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester PVF2 coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the steel runner. The clips shall be concealed and no fasteners are to penetrate the external sheeting. Insulation of density 100 Kg/m3 and average thickness 50 mm. conforming to IS 8183 having a thermal conductivity value of 0.034 W/mk at 50 degree C mean temperature. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

4.00.00 **EXECUTION**

4.01.00 **Inspection**

4.01.01 the contractor shall examine the area, which will be covered, and the masonry wall where the edge of the sandwich/double skin cladding will be fixed and the structural alignments.

4.01.02 Contractor shall correct any unsatisfactory conditions prior to start of work.

4.02.00 **Installation**

4.02.01 Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

4.02.02 Double skin wall cladding shall be installed strictly as per manufacturer specification and details.

4.02.03 All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

4.02.04 Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 **Clean-Up**

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

5.00.00 **RATES**

Rates shall be for unit rate for complete item described in the Schedule and shall include all wastages.

6.00.00 **METHOD OF MEASUREMENT**

a) No allowance shall be made for laps.

b) Roofing and side sheeting shall be measured for net area of work done. Corrugated / Trough sheeting shall be measured flat and not girthed. Openings less than 0.1 Sq.m shall not be deducted.

c) Special features like flashings, ridge pieces, caves, corner pieces, north-light curves etc. shall be measured for length of installation.

d) Gutter and down comers shall be measured for length along their centre lines and bends, junctions, shoes ends, etc. shall not be considered for measurement.

e) Opening area of Doors, Windows, Louvers, Cutouts which falls under metal clad area shall be measured for deduction form total metal clad / clad area.

f) Curved roofing sheets shall be measured for area of curve.

VOLUME : VII-C

SECTION-XIX

TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XIX : 1
2.00.00	INSTALLATION	VII-C/S-XIX : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XIX : 17
4.00.00	RATES	VII-C/S-XIX : 18
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XIX : 18
6.00.00	I. S. CODES	VII-C/S-XIX : 19

VOLUME : VII-C

SECTION-XIX

TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

1.00.00 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified in the "Schedule of Fixtures".

2.00.00 INSTALLATION

2.01.00 Materials

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from decay, fungal growth, boxed heart, pitch pockets or steaks on the exposed edges, splits, large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Ply wood shall be BWP grade or BWR grade as per IS 303. Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of B W R grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush door shutters shall have a solid core with commercial or decorative or non-decorative (Paintable type as per IS 2202 Part I) faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. 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 phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items". The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708.

Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0mm and 3.0mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.4 mm and 1.0mm for decorative veneers, provided that the combined thickness of both is not less than 2.2mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8mm to 10mm. The rebating shall be either splayed or square type as shown in the drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

Opening for glazing

When required, glazing shall be provided and unless otherwise specified the opening for glazing shall be 250mm in height and 150mm or 200mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25mm. Opening for glazing shall be provided where specified or shown in the drawing.

Tolerance

Tolerance on the width and height shall be +3 mm and tolerance on nominal thickness shall be ± 1.2mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

e) **Panelled Glazed or Panelled and Glazed Shutters**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per “Schedule of Items” and as per drawing or as recommended and approved by Engineer in charge.

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any wrap or bow and shall have smooth well planed face at right angles to each other.

Other considerations shall be as mentioned in item (d) above.

Window and Ventilator Shutters

Window and Ventilator shutters shall conform to IS 1003 (Part 2)

f) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616

Material

i) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued tighter having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5mm.

ii) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects or cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 percent.

iii) **Adhesives :** Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

iv) **Preservatives :** Veneers used for LVL shall be given preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall than be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf joined only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600mm.

Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

g) **Laminated Veneer Lumber (LVL) Door Shutters**

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals, etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricated shall take up manufacturing of shutters only if provisions of clause mentioned above fulfilled, failing which, shutters so manufactured are liable for rejection.

Panelling Materials

Plain Particle Board : Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board : Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per stated above.

Medium Density Fiber Board : Medium density fibre board used for panels shall confirm to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board : Pre-lamination in pre-laminate medium density fiber board shall confirm to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per stated above.

Glass: Glass for glazing shall confirm to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass may also be specified by the Engineer-in-Charge.

Wire Gauze : Wire gauze shall generally confirm to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

h) **Construction and Workmanship**

Laminated Veneer Lumber (LVL) paneled, glazed and panelled and glazed shutter shall be constructed in he form of LVL framework of stiles and rails with panel inserted conforming (as per stated above) of plain or perlaminated particle board, plain or perlaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beadind as specified. The stiles top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutters complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon and mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any wrap and bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

Beading : All the panels except glass and wire gauze shall be fixed with grooves but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable handless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401–1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Muliions and glazing bars shall be stubtenoned to the maximum depth which the size of the member wood permit or to a depth of 25 mm, whichever is less.

The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL shutters shall be manufactured in factories under controlled conditions.

i) **Panelling**

Plain and perlaminated Particle Board Panelling : The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

Wire Gauze Panelling : Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

j) **Rebating**

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or squire type as per IS 1003 (part-1).

k) **Gluing of Joints**

The contact surfaces of tenon and mortice shall be treated before putting together as per IS 1003 (part-1). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

l) **Tolerances**

Tolerance on the size of door shutter shall be +3 mm and in thickness +1.2 mm.

m) **Location of Fittings and Accessories**

Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50

mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per scheduled by the user. The fittings shall conform to specifications as described above.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, size and shape of louver or vision panel opening shall be as specified.

n) **Finish**

All the four edges of the shutter shall be squire. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

o) **Glazing**

Glazing in the shutters of door and window shall be as per in specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

p) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the “Schedule of Fixtures”. However minimum number of fixtures shall be as follows :

1. **For external single leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.

- Heavy duty automatic door closer.
- Rain drip

2. **For external double leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge on both shutters.
- 10mm dia & 300mm long SS tower bolt on inside face on both shutters.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer on active shutter.
- Rain drip

3. **For external single leaf window :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- SS pull ring minimum 6mm thick and 50~75mm dia.
- SS window stay piece.

2.02.00 **Partitions**

These shall be conform to drawings an all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

a) **Materials**

Gypsum Board conforming to IS 2095 (Part-1)

Non asbestos multi-purpose cement board conforming to IS 14862
Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminium or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

b) **Installation**

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Jointing & Finishing**

Joints of the boards are finished with specially formulated joining compounding and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

d) **Fitting and Fixtures**

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

e) **Tolerance**

Tolerance in dimensions shall be ± 5 mm.

2.03.00 **UPVC-Door Frames**

a) **Material**

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desied proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

b) **UPVC Door Frame**

UPVC door fame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extrude UPVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm ± 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm ± 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The fames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the fames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

2.04.00 **PVC Door Shutters**

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

24 mm thick PVC Door Shutter
30 mm Thick PVC Door Shutter
Sampling and Criteria for Conformity

a) **General Precautions**

The test specimens shall not have been exposed to a temperature below 400C for 24 hours immediately preceding the test and shall be free from all / visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

If the test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

b) **Sampling**

Sampling criteria for conformity shall be in accordance with IS 4020 (Part-I)

Lot in any Consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to from a lot.

The number of shutters to be selected at random from a lot shall depend upon its size.

c) **Fixing of Shutters**

PVC door shutters shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm / 30 mm. The hinges used should be of stainless steel.

d) **Tolerance**

The tolerance on the width and the height of the door shall be ± 5 mm and the tolerance on the nominal thickness of the door shall be ± 2 mm.

e) **Fittings**

Fittings shall be provided as per scheduled of fittings decided by Engineer-in-Charge. In moisture prone areas M.S fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

2.04.00 **PVC Door Frame**

Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minium of 1.5 kg./sqm. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be jointed to each other using solvent adhesive conforming to IS 14182. A tolerance of ± 3 mm. shall be permitted in the specified dimension of PVC section in the door frames.

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge.

Fixing of Frames : As stated earlier

2.04.00 **Panel PVC Door Shutter**

Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-Charge.

a) 30 mm thick panel PVC door shutters.

2.05.00 **Fibre Glass Reinforced Plastic (FRP) Door Frames**

Door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up to resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./sqm. and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

a) FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

b) **Tolerance :** Tolerance of size of frame to be ± 2 mm. and on size of rebate to be +1 mm.

c) **Finish :** The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour bolts and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour and shade as approved by Engineer-in-Charge.

d) **Fixing of Frame :** As stated earlier.

2.06.00 **Fibre Glass Reinforced Plastic (F.R.P.) Shutters**

a) F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

b) Blocks of any seasoned hard wood of bulk density not less than 450 kg / cum At 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

c) **Location of Fittings and Accessories :** The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable location by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminium.

d) **Sampling & Criteria for conformity :** As stated earlier

e) **Finish :** Stated earlier

f) **Fixing of Shutter :** Stated earlier

g) **Tolerance:** Stated earlier

2.07.00 **Solid PVC Fome Profile Doors**

a) **Solid PVC Foam Profile Frame**

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge. PVC door frame should have shore hardness more than 70.

b) **Fixing of Frames:** Stated earlier

2.08.00 **Solid PVC Foam Shutters**

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Door are provided with naturally strong stiffener frame and sandwich paneled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

a) **28 mm Thick Door Shutters**

Profile is cut in required length to make vertical & horizontal site. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffener 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is jointed using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicon sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look.

The fabrication shall be done in done in factor as per nomenclature of the item and directions of Engineer-in-Charge.

b) **Sampling and Criteria for conformity :** Stated above

c) **Fixing of Shutters:** Stated above

d) **Tolerance:** Stated above

e) **Fittings:** Stated above

2.09.00 **Factory Made Fibre Glass Reinforced Plastic Chajja**

F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge.

Material

1) Glass Fibre (chopped strand mat) shall be as per IS 11551
2) Unsaturated Polyester Resin shall be as per IS 6746
3) Surface Burning Characteristics of Building Material – ASTM E84-77a
4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
5) Curing Agents – Cobalt Napthanate and MEKP
6) Test of Products – IS 14425
7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modules of elasticity, good textile processing and excellent fiver reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

Tolerance

Tolerance of ± 10 mm in overall size of FRP chajja is permissible.

2.10.00 **Workmanship**

2.10.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

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. that 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 particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS 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 or schedule of items.

2.10.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. 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.

2.10.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **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**

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 **Pelmets, 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 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.03 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, holding chains, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.04 **Drawers**

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.05 **Loose Furniture**

When placed on level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **RATES**

Rates shall be unit rates including preservatives, shop coats, primers varnishing, polishing etc. against items mentioned in Schedule. No separate payment will be made for fixing caulking etc. unless separately provided for in Schedule.

5.00.00 **METHOD OF MEASUREMENT**

5.01.00 **Door and Window Frames, Handrails etc.**

Woodwork in frames handrails etc. shall be measured for the volume of timber used, i.e. the minimum theoretical rectangular section from which the shape can be obtained multiplied by the length of timber required. In computing the length, timber required for tennons, scarves, embedding to walls over the finished length shall be added. Mitred pieces shall be measured along the longest length.

5.02.00 **Holdfasts**

Shall be measured for actual number used.

5.03.00 **Door and Window Shutters**

Shall be measured for actual outer area of shutters for different thickness and types described in Schedule.

5.04.00 **Glass and Glazing**

Shall be measured and paid separately under relevant items.

5.05.00 **Fittings and Fixtures**

Shall be measured separately in actual numbers used for different sizes and types described in Schedule.

5.06.00 **M S Grills and Guard Bars**

Shall be measured and paid separately under relevant items.

5.07.00 **Partitions, Paneling, etc.**

Shall be measured for actual area excluding door shutters. Door shutters shall be measured and paid separately under relevant items.

5.08.00 **Pelmet, Shelves, etc.**

Shelves shall be measured for actual area of finished surface. Pelmets shall be measured for length of different types enumerated in the Schedule.

5.09.00 **Furniture**

Shall be measured for actual number of each type.

6.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS : 4021 - Timber door, window and ventilator frames

IS : 1003 - Timber paneled and glazed shutters.

IS : 2191 - Wooden flush door shutter (Cellular and hollow core type)

IS : 2202 - Wooden flush door shutters (Solid core type)

VOLUME : VII-C

SECTION-XX

TECHNICAL SPECIFICATION
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XX : 1
2.00.00	INSTALLATION	VII-C/S-XX : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XX : 19
4.00.00	INFORMATION TO BE SUBMITTED	VII-C/S-XX : 20
5.00.00	RATES	VII-C/S-XX : 21
6.00.00	METHOD OF MEASUREMENT	VII-C/S-XX : 21
7.00.00	I. S. CODES	VII-C/S-XX : 22

VOLUME : VII-C

SECTION-XX

TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. The scope of work shall also include the assembly and the Owner from the store at site shall supply erection of all doors, windows, louvers, glazed partitions, etc. for which fabricated materials. 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 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 Tenderer 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 Contractor’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 in schedule. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced 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 Contractor 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 Contractor towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.02.00 **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”.

d) **Sliding Doors**

These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheet.

The shutter shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted/ welded together with 3mm gusset plate at junction to form a rigid frame. Sliding doors shall be either double plate or single plate construction as called for in drawings and schedules made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer’s catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in the Schedule of Items, these shall be provided with top and bottom guide rails of specified size angles or T-irons and 25mm diameter pulley or with 25mm diameter ball bearing at the bottom and guide block with steel pulleys at the top. The shutters shall be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of item. Doors shall close positively to exclude rainwater from seeping in. When called for in schedule, sliding doors shall withstand specified wind

loads without buckling or jamming. The door shall slide freely under all ambient conditions.

The guide rail shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can against the walls, giving full opening when so required.

FIXING : The guide rail shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitably fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

The adjoining work damaged in fixing shall be made good to match the existing work.

e) **Door Threshold**

Door threshold shall be provided as shown on drawing. 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 and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 **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.

2.02.03 **Fire Door**

Hollow metal fire rated doors should be as per IS 3614 Part-1 & Part-2.It should be made of pressed Galvanised steel conforming to IS 277. It should be tested at CBRI or ARAI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision lites/ panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates will not be allowed. Proper label conforming the type of door and the hourly rating is mandatory.

Door Frame : Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60mm (16 gauge) minimum thick G.I. sheet (zinc coating not less than 120gm/sqm) duly filled with vermiculite based concrete mix. Suitable for mounting 60 minutes fire rated door shutters. The frame is fitted with intumuscent fire seal strip of size 10 x 4 mm (minimum) all-round the frame and fixing with dash fastener of approved size and make, including applying a coat of approved brand fire resistant primer. Frames shall be metered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the skirting jamb. Frames should be provided with

black plate bracket for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry of approved proportion necessary for fire doors on the clear masonry opening.

Door Shutter : Door shutters will be 50 mm thick (unless otherwise stated in the drawing) of 60 minutes fire rating conforming to IS: 3614(Part-II) tested and certified as per laboratory approved by Engineer-in-Charge with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, shall fully flush double skin door with or without vision lite. Door shall be manufactured from 1.6 mm (16 gauge) minimum thick SWG G.I. sheet (zinc coating not less than 120gm/sqm) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make (if mentioned in the drawing) including applying a coat of approved fire resistant primer. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. All doors shall be factory prepared for receiving appropriate hardware and provided with necessary reinforcement hinges, locks and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. 200 x 300mm Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

The door leaf and frame shall have passed minimum 250hours of salt spray test.

Paint : All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour.

Rate : Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

2.03.00 **Structural Glazing**

Aluminium semi unitised vertical Structural glazing system with single glass vision panel and spandrel panel of approved make having main frame of verticals and horizontals made out of specially designed extruded aluminium sections to withstand wind pressure of 175 kg/sq.m at a height of 40m and fabricated, fixed at all levels, elevation and heights to the Masonry / RC walls with necessary clamps, brackets and anchor fasteners. All clamps and brackets shall be Mild Steel Hot dip galvanized minimum 80 microns thick and shall conform to IS: 4759-1996. The extruded aluminium section shall be anodised in approved colour with a anodic coating of minimum 20 microns. Extruded section shall be of 6063 T5 or T6 alloy conforming to ASTM B 221. Any other fastening straps, nuts, bolts, rivets, washers, Fire stops at all floor levels etc. shall be in stainless steel SS 304 grade. All tapes shall be of approved make.

The system shall be designed to withstand a wind pressure of 200 kg/Sqm and shall be fixed to the masonry/RC walls with necessary clamps, brackets and anchor fasteners, clamps and brackets shall be Hot dip galvanized minimum 80 microns thick, all complete as per manufacturer's manual and specifications. The spandrel panel shall have 50mm thick fiber glass insulation of 48 kg/cum density of approved make conforming to IS-8183 and 1.0 mm thick Twiga black tissue conforming to BS 476 Part 7. This insulation shall be enclosed in a GI tray fabricated out of 1mm thk. GI sheet and fixed to the glazing framework with stainless steel fasteners.

The gap between the GI framework and the concrete framework shall be sealed with Aluminium flashing fixed with stainless steel fasteners. All gaps shall be sealed with Silicone sealant of approved brand. Insulation should be provided in between the Structural glazing aluminium frame work (i.e., behind the spandrel glazed panel) and the structure. Providing 6 mm thick toughened fully tempered hard coated glass of blue/green/blue-green or approved colour having VLT = 35 to 50 % ,External reflectance= 6 to 15% ,Internal reflection = 8 to 15%, Solar factor = 0.36 to 0.43, U Factor = 2.8 to 3.0 W/sqm K etc.

2.04.00 **Aluminium Curtain Wall System**

2.04.01 **General**

1) Aluminium Curtain Wall System shall be designed for the following effects :

   a) Permanent Deformation, thermal expansion.

   b) Wind and seismic load

   c) Air and water infiltration or leakage.

   d) Lateral deflection per floor height

2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC / Department for approval after detailed scrutiny and checking design calculations and drawings.

3) The work shall bear five years guarantee. It will be obligatory on the part of the contractor to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC / Department.

2.04.02 **Specification for Materials used for Curtain Wall**

1	Glazing	Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass & Glazing of this book.
2	Framing system	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	Sealant	As specified in the item or silicon sealant
4	Insulation	50 mm thick rock wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion
5	Heat Reflective Toughened Glass	As specified elsewhere in the specification. Colour of any shade approved by the Engineer-in-Charge.

2.04.03 **Aluminium Alloy Extruded Sections**

Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works. Dimensions and weights of the sections shall be as per approved drawings.

2.04.04 **Components, General specifications, Glazing, Panelling etc. for Curtain Wall System :** These shall be generally as per relevant Chapters in this book.

2.04.05 **Scope of Work**

2.04.05.01 **Preliminary Requirements**

i) The contractor shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.

ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings,

iii) **The curtain wall system shall also include the following activities :**

a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.

b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.

c) All thermal insulation associated with the system. (d) All fire protection associated with the system.

d) All copings and closure and metal cladding to complete the system.

e) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.

f) Isolation of dissimilar metals and moving parts,

g) Anticorrosive treatment on all metals used in the system, (i) Polyester powder coating aluminium sections,

iv) **The contractor shall also be responsible for providing the following :**

a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

b) Mock-ups, samples and test units.

c) Performance testing of the curtain wall framing and glazing assembly. (d) Co-ordination with the work of other trade.

d) Insulation with glass wool 48 kg/cum at spandrels area.

e) All final exterior and interior cleaning and finishing of the curtain wall system.

f) Protection.

g) As built record drawings and photographs.

h) Guarantees and warranties.

i) All hoisting, scaffolding, staging and temporary services.

j) Conceptualising and design of a suitable maintenance system for curtain glazing,

v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good all at the risk and cost of the contractor.

vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

2.04.06 **Design Requirements**

i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.

ii) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

2.04.06.01 **Basic requirement**

The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the contractor may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

2.04.06.02 **Quality Consideration and other Activities**

i) The contractor while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:

1) Metal quality, finishes and thickness

2) Glass quality, coating and thickness and proposed manufacturer's brand names.

3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer's brand name and also the name of agency proposed for fabrication work.

4) Arrangement and jointing of components.

5) Field connections especially mullion to mullion and transom to mullion.

6) Fixing and anchorage system of typical wall unit together with structural calculations.

7) Drainage system and provision in respect of water leakage in the curtain wall system.

8) Provisions for thermal movements.

9) Sealant and sealing methods.

10) Glazing Method

11) Wind load and seismic load and any other specific load considered in the design

ii) Design concept over lighting protection link-up system of the curtain wall for connection and incorporation into the lighting conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).

iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

2.04.06.03 **Tolerances :** Any parts of the curtain wall, when completed, shall be within the following tolerances:

1) Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.

2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.

3) Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

2.04.06.04 **Samples :** The contractor shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the tender proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

2.04.06.05 **Ancillary Requirements to be fulfilled by the contractor**

i) The contractor / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.

ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the contractor at his own cost, without claiming any thing extra under any circumstances.

2.04.07 **Execution of work**

2.04.07.01 Performance Testing - General Requirements

i) Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.

ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test unit for performance testing of the curtain wall shall be constructed by the contractor at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.

iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

iv) The contractor shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

v) Prior to the fabrication of test units, the contractor shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.

vi) The contractor shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.

vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the contractor.

2.04.07.02 **Test of Wind Pressure**

i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.

ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.

iii) The variation of dynamic pressure shall be of any approximate sine curve line.

iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.

v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

vi) The deflection on the main structural parts in this condition shall not exceed :

1) 1/175 of the span between supports or 20 mm, whichever is less for vertical elements.

2) 1/250 of the span between supports for horizontal elements.

3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

2.04.07.03 **Test of Lateral Deflection per floor height**

i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)

iii) The dynamic deflection shall be applied up to ± 13 mm.

iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.

v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.

vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

2.04.07.04 **Water-tightness Test**

i) Water shall be sprinkled to the Test Unit' under wind pressure.

ii) Pressure shall not be applied to the test unit.

iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.

iv) All water leakage and drainage system at the joint and the open able sash of the curtain wall system shall be observed from the outside of the chamber.

v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.

vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness test.

1) Install the test unit.

2) Hold first water-tightness test.

3) Hold test of wind pressure as described above.

4) Hold second water-tightness test.

5) Lateral deflection test.

2.04.07.05 **Test Report :** The contractor shall submit five copies of test report to the Engineer-in-charge.

2.04.07.06 **Cost of Performance Test**

i) The contractor shall allow in his tender for the cost of the performance testing and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.

ii) The contractor shall allow for amendments and adjustments to the mock-up unit as instructed and required by the Engineer-in-Charge / Architect or the consultant.

iii) If the mock-up test unit fails to pass the initial testing, the contractor shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.

iv) Cost of corrections to the test unit and the cost of retesting shall be borne by the contractor.

v) The contractor shall be allowed six calendar months time after the work is awarded to set up the test unit and conduct the required test as described above to the satisfaction of the Engineer-in-charge.

vi) In case the contractor fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to rescind the contract with all costs including the forfeiture of E.M.D. and any other securities deposited by the contractor under the condition of contract.

2.04.07.07 **Record of Test and Drawings**

i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.

ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.

iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

2.04.07.08 **Fabrication and Erection**

i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, which have been cut to length, mitred and mechanically jointed at the corners, Sub-dividing bar of units shall be tenoned and riveted into frames.

All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.

ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

iii) The sizes of different members of the curtain wall system shall be exactly as adopted for the mock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.

iv) Care should be taken to see that any gap between the frame and support and the frame **itself is sealed with silicon sealant.**

v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.

vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

2.04.08 **Representative of the contractor**

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

2.04.09 **Performance Guarantee**

The contractor shall provide a performance guarantee as indicated in the Schedule of Quantities for a period of five years, to provide for expenses to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period shall start from the date of completion and handing over of the project.

2.04.10 **Measurements**

i) The breadth and the height of the finished work including the openable windows shall be measured in metres and cm and the net quantity for payment shall be calculated in sqm up to two places of decimal.

ii) The area to be considered for measurement shall be the net area of the exterior face of the curtain wall as fixed including the openable windows, if any, as part of the curtain wall.

2.04.11 **Rate**

The rate shall include the cost of all operations described above including the cost of materials, labour, design, shop drawings, erection and testing, mock-up test units, fabrication, erection, finishing, scaffolding, undertaking performance guarantee etc. No other claims of any kind pertaining to this work shall be entertained.

2.05.00 **Aluminium Sun Louver With Stringer System**

Plain panel Aluminium Sun Louver system as per manufacturers specification of approved colour, shall consists of panel 84 mm wide x 16 mm deep x 0.6mm thick in standard length of upto 6m. The panel shall be coil coated in a continuous paint line, double baked and roll formed from stove enameled corrosion resistant aluminium Alloy AA 5050/3005 for higher strength and roll forming characteristics. The panel shall be clipped on to a backed & enamelled aluminium stringer 33mm wide x 86mm deep made from 0.95mm thick backed & enamelled aluminium alloy AA 5050 (sl.mg.) in standard length of 5 m in white colour with cutouts to hold the panels in a module of 86mm c/c. The first stringers shall be fixed at 150mm from both ends and thereafter at a distance of 0.75mm c/c depending on wind load. The stringer shall be fixed to a suitable sub-structure/wall with Nut/Bolt and washer.

Paint Finish

Panel shall have exterior paint finish which will be of 3 layers:

The Anorcoat Pretreatment

The colour coating and

Transparent top coat

The paint used shall be epoxy based & finished with a polyamide/Nylon coating. The paint system shall have the following characteristics.

Coating thickness	:	24-32 Microns
Gloss	:	28 (+/-5)
Gloss Variation	:	+/-3 units (within delivery)
Adhesive Impact/Bending	:	No Loss of Adhesive
Durability	:	Higher Category
Humidity Resistance	:	Blisters less than size 2

2.06.00 **Shop Coat or Paint**

The shop paint for steel doors, windows, etc. shall be best lead or zinc chromate primer paint from approved manufacturer 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.

Where called for in the Schedule of Items all steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 Oz per sft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

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 Contractor shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of 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 Contractor 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 manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Contractor mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one 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.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed 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 **With Tender**

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 **After Award**

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 RATES

Rates shall be unit rates for items described in schedule.

6.00.00 METHOD OF MEASUREMENT

a) Supply and installation of doors shall be measured in number of each type used. The types shall be as shown on drawings and described in Schedule of Items.

b) Supply of windows shall be measured in number of each type of unit used either single or in combination.

c) Installation including assembly and erection of windows shall be measured in number of types of combinations mentioned in the Schedule of Items.

d) Supply and installation of louvers shall be measured for area of opening in which the louver is to be installed.

e) Supply of mullions and transoms shall be measured for net length of different types shown on drawings and described in Schedule. In computing the length, the length required for embedding in concrete or masonry shall not be considered. No extra payment shall be made for end or cover plates.

f) Vision panels, louvers to doors and insulation between door faces shall be measured for actual area and paid separately over the basic rate doors.

g) Glazing beads, weather stripping, fixing devices etc. shall not be measured separately but shall be included in the supply rate of respective items.

h) And curing or grouting to concrete and masonry or welding and drilling to steel required for installation shall be included in the installation rate. No separate payment shall be made for caulking and jamming or frames or making good to concrete or masonry.

I) Glass and glazing shall be measured and paid under relevant items.

j) Door and window fixtures, locks, door closures etc. shall be measured in actual numbers use.

7.00.00 **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
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

VOLUME : VII-C

SECTION-XXI

TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS, GRILLS AND COLLAPSIBLE DOORS

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXI : 1
2.00.00	INSTALLATION	VII-C/S-XXI : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXI : 8
4.00.00	RATES	VII-C/S-XXI : 9
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XXI : 9
6.00.00	I. S. CODES	VII-C/S-XXI : 9

VOLUME : VII-C

SECTION-XXI

TECHNICAL SPECIFICATION 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/Grills/partly closed and partly grilled/collapsible doors 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 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) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the 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.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 **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 openings upto 9 sq. metre in area. Larger shutters shall be either chain or gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule or 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 or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 **Rolling Shutters without grill**

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 or operated with mechanical device supplied by the firm. Shutters up to 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

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 tortional load with a maximum deflection of $1/360^{th}$ 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 unless otherwise stated in Schedule or 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.

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.

Measurements :

Clear width and clear height of the opening for rolling shuttering shutter shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

Unless included in the main team, whether stripping at bottom bar and mullions shall be measured separately for length.

Cylinder locks shall be for actual numbers used. Pad locks shall be supplied by others.

Rate

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

2.05.00 **Rolling Grills – Shutters**

Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter-cum grill shall not exceeded 1.0m and the height of the grill portion in any individual segment shall not be more than 0.5m.

Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 10.8 shall be applicable to rolling grills shutters except in respect of the shutter portion and shall conform to IS 6248.

Shutters

Rolling grill shutter and the rolling grill portion of the rolling shutter-cum grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20mm wide and 5mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120mm and the depth of corrugation is 80 to 100mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughts of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

Measurement & Rate

The measurement and rate shall be as specified in clause 2.02.01(g). In case of Rolling Shutter-cum-Grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

2.06.00 **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. Wherever galvanized door not specified, the door shall be painted with synthetic enamel paint with two coats

2.07.00 **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.

2.08.00 **Collapsible Gate / Door**

2.08.01 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

2.08.02 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

2.08.03 **Fixing**

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centers alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

2.08.04 **Painting**

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

2.08.05 **Measurements**

The height and breadth shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square metres, correct to two places of decimal.

2.08.06 **Rate**

The rate shall include the cost of materials and labour involved in all the operations described above.

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 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 **RATES**

Rates shall be unit rates for complete items for supply and/or erection of rolling shutters, including all drives, accessories, hardware etc. No extra payment shall be made for cutting, drilling, welding, grouting etc. to structure for installation of the shutters.

The rates shall include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections.

5.00.00 **METHOD OF MEASUREMENT**

a) Rolling shutters or grills shall be measured for area of opening in which they shall be installed. Alternatively, shutters shall be measured for actual number of different sizes used.

b) Cylinder locks shall be for actual numbers used. Pad locks shall be supplied by others.

6.00.00 **I.S. CODE**

IS : 6248 - Metal rolling shutters and rolling grills.

IS : 10521 - Collapsible Gate

VOLUME : VII-C

SECTION-XXII

TECHNICAL SPECIFICATION FOR GLASS AND GLAZING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXII : 1
2.00.00	INSTALLATION	VII-C/S-XXII : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXII : 5
4.00.00	RATES	VII-C/S-XXII : 5
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XXII : 5
6.00.00	I. S. CODES	VII-C/S-XXII : 6

VOLUME : VII-C

SECTION-XXII

TECHNICAL SPECIFICATION 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 not be included in this scope.

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, 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 4 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 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) Obscure glass shall have a cast surface in one side.

c) 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.

d) 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.

e) 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 contractor 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 0º 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-valve) :** 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.

Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

Types of Coatings : There are two types of reflective glass, Pyroltic (Hard) coated and vacuum (soft) coated.

i) **Pyroltic :** It is a coating applied during glass manufacture. The coating is fused in to the glass at 1200ºC.

ii) **Vacuum Coated Glass :** It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than Pyroltic products.

Performance of Reflective Glass : The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio in %age
1.	Visible Light - Transmittance (%) - Reflectance (%)	 15-46 12-24
2.	Total Solar Energy: - Transmittance (%) - Reflectance (%)	 16-24 8-12
3.	Ultra Violet Rays: - Transmittance (%)	 2-10
4.	U-Value - Summer - Winter	 0.58 0.45
5.	Shading Coefficient	0.25-0.35

Testing : The reflective glass shall be tested for the followings :

i) Physical/Field Test: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

ii) Laboratory Test: In the laboratory, the reflective glass shall be tested for the parameter specified in the table above.

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 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 Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Contractor. The Contractor shall be responsible for damage of glass supplied by the Owner, during handling, transportation, fixing etc maximum wastage allowance shall be 5%.

After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones 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 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 RATES

a) Rates shall be unit rates for supply and / or installation of different kinds of glass mentioned in the Schedule of Items.

b) No separate payment shall be made for glazing clips, mastic cement, putty, nails etc. for drilling holes in frames for inserting glazing clips.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc.

d) No separate payment shall be made for cleaning the glass after installation.

5.00.00 METHOD OF MEASUREMENT

All supply and / or installation of glass shall be measured for actual area of work done.

6.00.00 **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.

VOLUME : VII-C

SECTION-XXIII

TECHNICAL SPECIFICATION
FOR
FLOOR FINISHES AND ALLIED WORKS

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXIII : 1
2.00.00	INSTALLATION	VII-C/S-XXIII : 2
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXIII : 47
4.00.00	RATES	VII-C/S-XXIII : 47
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XXIII : 48
6.00.00	I. S. CODES	VII-C/S-XXIII : 48

VOLUME : VII-C

SECTION-XXIII

TECHNICAL SPECIFICATION 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**

i) Integral finish to concrete base

ii) Red Oxide of Iron finish

iii) Terrazzo finish

iv) Granolithic finish

v) Patent Stone

vi) Metallic Hardener like “Ironite” or equivalent finish

vii) Mastic Asphalt finish

viii) Chemical Resistant finish

b) **Tiled Finishes**

a) Terrazzo tile

b) Chequered tile

c) Glazed tile

d) Tesserae (Mosaic etc.)

e) Chemical Resistant

f) Rubber, Vinyl etc.

g) Stone slab

h) Steelcrete tile

i) Vitrified tiles

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 Contractor 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 Contractor 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 Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, 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 **Integral Finish to Concrete Base**

Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, courtyard, kitchens & baths shall have slope ranging from 1:48 to 1:60 depending upon location and decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer-in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6mm to 10mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it. 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 a possible by using 2.2 kg. of cement per sq.m. of area. in verandah, courtyard.

Laying

Panels : Flooring of specified thickness shall be laid in the pattern including the borders given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450mm in width and the joints in the boarder shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

Laying of Flooring with Strips : Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4mm thick glass strips or 2mm PVC strips or 2mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun. Cost of providing and fixing strips shall be paid separately.

Concreting : Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

Laying of Flooring without strips : Laying of cement concreting flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.

Shuttering : The panels shall be bounded by angles iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

Concreting : The concreting shall be done in the manner described earlier. The angle iron/flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1:2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid

panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

Finishing

The finishing of the surface follow immediately after the cessation of beating. The surface shall be left for some time till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 to 2.2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edge of the sunk floors shall be finished & rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

The junction of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

Curing

The curing shall be done for a minimum period of ten days. The surface shall be kept in shade for 24 hours and then cured for at least 10 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

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.

Precautions

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.’s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4ºC. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot whether, precautions shall be taken to see that the temperature of wet concrete does not exceed 38ºC. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

Measurement

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

2.01.02 **Red Oxide of iron finish**

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius off 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) **Topping**

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) **Laying**

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with slurry made with already prepared cement and pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m for horizontal surface, and 1.0 kg for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) **Polishing**

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.01.03 **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 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1 1/2 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water is to be added to give a workable consistency. The panels shall be of uniform size, not exceeding 2 sqm in area or 2 m in length for inside situations. In exposed situations, the length of any side of the panel shall not be more than 1.25 metre. Cement slurry @ 2.00kg per sqm shall be applied before laying of under layer over the base cement concrete/RCC base.

ii) **Fixing of Strips**

4 mm thick glass strips or 2mm thick PVC strips/aluminium strips/brass strips/stainless steel strips/copper strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or any other material of specified thickness can also be used if specifically required. Use of glass and metallic strips shall be avoided in areas exposed to sun. The fixing and laying shall be as specified earlier.

iii) **Topping**

The mix for the topping shall be composed of cement, with or without colour pigment, marble dust, marble chips and water. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of

the two to which pigment shall be added to achieve the desired colour. 3 parts of this mixture 1 part marble powder by volume or weight 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 marble chips shall be white or pink Makrana, black Bhainslana, Chittor black, Jaisalmer Yellow, Baroda green, Dehradun white, Chittor pink, yellow Patam cherala (Madras), Grey Gadu (Surat), Chitoor green and yellow and Alwar black or as specified. It shall be uniform in colour and free from stains, cracks, decay and weathering. The maximum thickness of the top layer for various sizes of marble aggregates (marble chips) shall be as shown in Table below.

Grade No.	Size of Aggregates in (mm)	Proportion of Aggregates to Binder Mix	Minimum Thickness of Top Layer(mm)
00	1 – 2	1.75:1	6
0	2 – 4	1.75:1	6
1	4 – 7	1.75:1	9
2	7 - 10	1.5:1	12

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than one and one third times the maximum size of the chips. Where larger size chips such as 20mm or 25mm are used, it shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of wearing layer.

Before starting the work, the contractor shall get the sample of marble chips approved from the Engineer-in-Charge. This shall be done in advance by mixing different colour marble chips and panel samples of minimum 1 m x 1 m size shall be prepared and got approved from the Engineer-in-Charge before laying of flooring. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the Engineer-in-Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour. This mixture shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogeneous and stiff and contain just sufficient water to make it workable.

The pigment must be stable and non-fading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. 30. The size of marble chips may be between 1 mm to 10 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 2 sq.m. in area of which no side shall be more than 2.0 M long. 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 as stated earlier shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. Slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) **Curing**

The surface shall be left for curing for about 12 to 18 hours depending on atmospheric temperature conditions and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) **Grinding and Polishing**

The grinding and polishing may be commenced not before 2 days from the time of completion of laying for manual grinding and not before 7 days for machine grinding. When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of final rubbing polishing.

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 33 gm. per. sq.m sprinkled with water on to it and rubbed hard with a nemdah block (Pad of Wooden rags). 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.

Curing shall be done by suitable means such as laying moist sawdust or ponding water.

Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4ºC. The concrete placed shall be protected

against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see the temperature of wet concrete does not exceed 38ºC. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

2.01.04 **Wax Polishing**

Application, Polishing and Precautions

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the flooring/skirting.

When the layer of the wax is shifted and surface of the floor is saturated with the polish, polishing shall be restored with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

The fresh polished wall surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

2.01.05 **Crazy Marble Flooring**

Base Concrete

Crazy marble stone flooring shall be laid on cement concrete base. The base concrete shall be provided with slope required for the flooring in verandahs and courtyards to drain off washing and rain water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating coat of cement slurry at 23 kg of cement spread over an area of one sqm so as to get a good bond between base and flooring.

Before laying the flooring on RCC slabs, the laitance shall be removed, the surface of slab hacked and a coat of cement slurry at rate of 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between RCC slab and floor.

Under layer

The under layer of crazy marble flooring shall be of cement concrete of thickness 25mm or as specified. The mix shall normally be 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) by volume unless otherwise specified.

Top layer

The mix of crazy marble stone flooring shall consists of white cement with or without pigment, marble powder, marble chips of 00 Nos. and marble stone

pieces and water. The marble stone pieces shall be hard, sound, dense and homogeneous in texture with crystalline and concrete grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. Before starting the work the contractor shall get the sample of marble stone approved by the Engineer-in-Charge. The marble stone pieces shall be of sizes as approved by the Engineer-in-Charge but the thickness shall be according to the overall thickness specified which could be achieved when laid over the under layer as specified. Thus for 50mm thick floor, the thickness of marble pieces will be 25mm while for 40mm thick floor, the thickness will be 15mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix. The marble chips shall be as specified. It shall be hard, sound, dense and homogeneous in texture. It shall be uniform in colour and free from stains, cracks decay and weathering.

Laying

A coat of cement slurry at the rate of 2 kg of cement per sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

Polishing

Curing and Finishing shall be as described earlier.

Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned.

Measurements

Length and breadth shall be measured correct to a cm before skirting, dado or wall plaster and it shall be calculated in sqm correct to two decimal places. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metres. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metres. Nothing extra shall be paid for laying floor at different levels in the same room or courtyards.

2.01.06 **Granolithic Finish**

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) **Thickness**

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) **Mix**

The mix shall consist of 1 part cement: 1 part coarse sand: 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) **Laying of Monolithic Topping**

The concrete base shall be laid as per specification “Cement Concrete” and levelled up to 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 it is considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone-chips.

For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern.

d) **Laying of Topping Separately on Hardened Base.**

The base concrete shall be prepared as stated in clause 7.1.2.0.3 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.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.07 **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 2.01.03(a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.01.03 (b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as 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 levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall 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.

2.01.08 **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.

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.

2.01.09 **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 or schedule of items.

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural 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 and 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be re-melted 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 re-melting and mixing process, shall the temperature exceed 205^{o} C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.10 **Acid or Alkali Resistant Tiles**

Manufacture and Finish

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100ºC and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogeneous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 x 98.5 mm, 148.5 x 148.5mm and 198.5 x 198.5mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be ± 2 percent.

Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for square ness and warp as per IS 4457.

Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture.

Each tile may also be marked with the ISI certification mark.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The average thickness of the bedding shall be 10mm or as specified while the thickness for dado/skirting to be 12mm or specified on item.

Alkali resistant mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of acid alkali resistant cement per square metre over an area up to one square metre. Tiles shall be socked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tile has been laid surplus cement slurry shall be cleaned off.

Pointing and finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout the lugs remaining exposed. The floor shall then be kept wet for 7 days. After surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metres. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10squre metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of sizes up to 0.16 sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Swan) tiles in the work.

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 tile and an underbed.

a) **Thickness**

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) **Tiles: Terrazzo**

Terrazzo tiles shall generally conform to IS 1237-Edition 2.3. The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be manufactured in a factory under pressure process subject to pressed hydraulically to a minimum of 140 Kg. per sq.cm and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded. 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.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises

sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness +5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3mm on thickness. Face of the tile shall be plane, free from pinholes and other blemishes.

The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight. Where colouring material is used in the wearing layer, it shall not exceed 10 percent by weight of cement used in the mix.

The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest up to 6mm and also, not less than 5 mm for size of marble chips ranging from the smallest up to 12mm, and not less than 6mm for size of marble chips varying from the smallest up to 20mm.

The topping shall be as specified under clause 2.01.03 (b) (iii).

c) **Mix : Underbed**

Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion and in conformity with provisions in relevant para of chapter on 'Mortar'

Cement mortar 1:4 (1 cement: 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20mm and the thickness at any place shall not be less than 10 mm.

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, neat cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. The tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1 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 2.01.03 (b ii) may be used for dividing the work into suitable panels.

e) **Grinding and Polishing**

The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No.60). Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120)

The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding	-	coarse grade stone (No. 60)
Second grinding	-	medium grade (No. 80)

Final grinding - fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per sqm sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any tile is distributed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

2.02.02 **Chequered Tile Finish**

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) **Thickness**

Thickness shall be same as in clause 2.02.01

b) **Tiles: Chequered**

The tiles shall be of nominal sizes such as 20 x 20 cm, 25 x 25 cm and 30 x 30 cm or standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in-Charge. The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.2.1 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) **Underbed**

As per clause 2.02.01 (c).

d) **Laying**

As per clause 2.02.01 (d)

e) **Grinding and Polishing**

As per clause 2.01.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 **Pressed Ceramic Tile Flooring**

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tile shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1, 3, 5 and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width up to 2 mm for uncertified floor tiles and up to 2mm for uncertified floor tiles and up to 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tile shall conform to table 10 of IS 15622 with water absorption to 3% to 6% (Group BII)

The tiles surface of the tiles shall be glazed. Glazed shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50% of the surface area of the edges.

Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

Decorative Tiles

The type and size of the decorative tiles shall be as follows :

i) **Decorated white back ground tiles**

The size of these tiles shall be as per IS 15622

ii) **Decorative and having coloured back-ground**

The sizes of the tiles shall be as per IS 15622.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20mm or as specified while the thickness under any portion of the tiles not to be less than 10mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per squre metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

Pointing and Finishing

The joints shall be cleaned off the grey cement slurry 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 pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of size up to 0.16 sqm. Unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (swan) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

2.02.04 **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 tender schedule / 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.

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 / mm2
8	Abrasion resistance	< 204 mm2
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 in the schedule of items, 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 / Facia**

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 contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

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) **Mode of Measurement and Rate**

Dado / flooring / skirting shall be measured in sqm correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm. The rate shall include all the cost of labour and materials involved.

h) **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	Cleaning Agent
Iodine (Tincture iodine)	Sodium hydroxide / Potassium hydroxide
Hair dye	Per chloric acid
Paan	Lemon juice or citric acid
Marker pen	Acetone

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

2.02.05 **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.

2.02.06 **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 20 mm and 40 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. Mosaic tiles shall be of grey/white base as per the requirement and as per directives of Engineer-in–charge.

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 2.02.01(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 2.02.01(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.07 **Chemical Resistant Tiled Finish**

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.02.03.

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.

2.02.08 **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 mentioned in the Schedule or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be $\pm$ 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalise, 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 manufacture.

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: 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.09 **Stone Slab Finish: Marble, Stone and Similar Fine Grained Stone**

a) **Dressing of slabs**

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waive ness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surface is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

b) **Thickness**

The underbed shall be average 20 mm thick. The thickness of the slabs shall be 18, 30, or 40mm as specified in the description of the item. Tolerance of ± 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of ± 2% shall be allowed.

c) **Stone Slab**

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.

d) **Mix: Underbed**

Same as clause 2.01.03 (c).

e) **Laying**

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any place under the slab shall be not less than 12mm.

The slabs shall be laid in the following manner :

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/streaks or as directed by the Engineer-in-Charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

f) **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 2.01.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for. Cement slurry with or without pigment shall not be applied on the surface before each polishing.

2.02.10 **Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish**

Generally clause 2.02.10 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 up to ± 3 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.

2.02.11 **Marble Stone In Risers Of Steps And Skirting**

Marble Stone Slabs and Dressing of slabs shall be as specified in Clause no. 2.02.09 except that the thickness of the slabs shall be 18mm. A tolerance of ± 3% shall be allowed, unless otherwise specified in the description of the item.

Preparation of Surface

It shall be as specified in 2.02.05 where necessary; the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

Laying

The riser of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed in to the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but nor more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Curing, Polishing and Finishing

It shall be as specified in 2.02.01(e) as far as possible, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

2.02.12 **Kota Stone Flooring**

Kota Stone Slabs

The slabs shall be selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the sides of the stone shall be in full contact with it. The sides (edges) shall be table rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30, or 40 mm as specified in the description of the item. Tolerance of ± 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

Preparation of Surface and Laying

The specification as described in 2.02.10 except that the edges of the slabs to be joined shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

Polishing and Finishing

The specifications shall be as described in 2.02.10 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

2.02.13 **Kota Stone In Risers of Steps, Skirting and Dado**

Kota Stone Slabs and Dressing shall be as specified in 2.02.12 except that the thickness of the slabs shall be 25mm or as specified in the description of the item. The slabs may be of uniform size if required.

Preparation of surface shall be as specified in 2.02.11.

Laying shall be as specified in 2.02.11 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

Curing, Polishing and Finishing shall be as specified in 2.02.11 except that first polishing with coarse grade carborundum stone shall not be done.

2.02.14 **Wooden Flooring**

Seasoning and Preservation

All timber used for timber floors shall be thoroughly seasoned in accordance with IS 1141. After seasoning the timber shall be treated with preservative in accordance with IS 401. Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

Supporting Joists

Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-Charge shall be fixed in position to dead levels. The width of the joists shall not be less than 50mm. The arrangement and spacing of beams joists etc. shall be as per design furnished.

Boards

It shall be the class of timber and thickness specified in the description of the item. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall not be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of

boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra.

Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the squire butt type and shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

Iron screws

Iron Screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm, subject to a minimum of 40 mm, and of designation No. 9 confirming to IS 451.

Fixing

The joints on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and closed to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.

The floor shall be planed in both directions and made perfectly even, true and smooth.

Note : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilation in the space below the floor in case of ground floor and between floor and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

Finishing

The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-in-Charge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid for separately unless specifically included in description of the flooring item.

2.02.15 **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 $R10^8$ ohm as per ESD approval, SP-method 2472. Anti-static sheets should be confirming clean Room Test Class A as per ASTMF 51/100.

2.02.16 **Heavy Duty Cement Concrete Tiles (Steelcrete or equivalent)**

1. **Materials**

Cement - Cement used in the manufacture of tiles shall be ordinary Portland cement conforming to IS: 269-1976t or rapid hardening Portland cement conforming to IS: 8041-1978 or white Portland cement conforming to IS: 8042-1978t or Portland Puzzolana cement conforming to IS: 1489-1976.

Aggregates - Aggregates used in the backing layer of tiles shall conform to the requirements of IS: 383-1970s. For the wearing layer, unless otherwise specified aggregates shall consist of natural stone chips, like carborundum.

Pigments - Pigments, synthetic or otherwise, used for colouring tiles shall have durable colour. It shall not contain matters detrimental to concrete and shall according to the colour required be one of the following or their combination:

Pigments	**Relevant Indian Standard**
a) Black or red or brown pigment	IS: 44-196911
b) Green pigments	IS: 54-19757
c) Blue pigments	IS: 55-1970 or IS: 56-1975 or IS : 3574 (Part II)-1966
d) White pigments	IS: 411-196845
e) Yellow pigments	IS: 50-19791111 or IS : 3574 (Part I)-1965

Colours other than mentioned above may also be used. The pigments shall not contain zinc compounds or organic dyes. Lead pigments shall not be used unless otherwise specified by the purchaser.

2. **Manufacture**

2.1 Cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregates, and colouring material where required, by pressure process. During manufacture the tiles shall be subjected to a pressure of not less than 14 N/mm" (140 kg/cm").

2.2 The proportion of cement to aggregate in the backing of the tiles shall be not leaner than 1: 3 by mass.

2.3 Where colouring material is used in the wearing layer, it shall not exceed 10 percent by mass of cement used in the mix.

2.4 On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard. Tiles shall be stored under cover.

3. **Dimensions**

The size of cement concrete flooring tiles shall be as follows :

Length (mm)	Breadth (mm)	Thickness (mm)
200	200	20
250	250	22
300	300	25

Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles in the floor shall have dimensions which shall be such as to make two half tiles when joined together, match with the dimensions of the one full tile.

4. **Tolerances**

4.1 Tolerances on length or breath of tiles shall be ± 1mm. In addition the difference in length of side between the longest side and shorter side in the sample shall not exceed 1mm.

4.2 Tolerance on thickness shall be +5 mm. In addition the difference in thickness between the thickest and the thinnest tile in the sample shall not exceed 3 mm.

4.3 Thickness of Wearing Layer - The minimum thickness of wearing layer for the various classes of cement concrete flooring tiles shall be as specified in Table 1.

4.3.1 The thickness of the wearing layer shall be measured at several points along the fracture line of the tile that was tested for wet transverse strength in accordance with 11.5. The arithmetic mean of the two measurements which yielded the lowest value shall be the minimum thick- ness of the wearing layer.

TABLE 1 THICKNESS OF WEARING LAYER

SL. NO.	CLASSIC OF TITLE	MINIMUM THICKNESS OR WEARING LAYER (mm)
(1)	(2)	(3)
i)	Plain cement and plain coloured tiles for general purpose	5
ii)	Terrazo tiles with chips of riie varying from the smallest up to 6 mm, for general purpose	5
iii)	Terrazo tiles with chips of size varying from the smallest up to 12 mm, for general purpose	5
iv)	Terrazo tiles with chips of size varying from the smallest up to 20 mm, for general purpose	6
		6
v)	Plain cement and plain coloured tiles, for heavy duty	

5. **General Quality**

5.1 Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included), holes, cavities and other blemishes layer may be rounded.

6. **Finish**

6.1 The colour and texture of the wearing layer shall be uniform through-out its thickness. No appreciable difference in the appearance of the tiles, from the point of view of colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

6.2 When indenting for terrazzo tile, the purchaser shall state the size of chips to be used in the wearing layer of size 2B.

7. **Physical Requirements**

7.0 The tests on tile shall not be carried out earlier than 28 days from the date of manufacture.

7.1 Flsitness of the Tile Surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.

7.2 Perpendicularity - When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.

7.3 Straightness - When tested the gap between the thread and the plane of the tile shall not exceed 1 percent of the length of the edge.

7.4 Water Absorption - When tested according to the procedure laid down by the method for determination of water absorption that is given below, the average percentage of water absorption shall not exceed 10.

8. **Method For Determination Of Water Absorption**

1. Six full size tiles selected in accordance with 14 shall be used for the test. They shall be immersed in water for 24 hours, then taken out and wiped dry.

2. Each tile shall be weighed immediately after saturation and wiping as in D-l. The tile shall then be oven-dried at a temperature of 65 f (±) 1°C for a period of 24 hours cooled to room temperature and reweighed.

3. The water absorption for each tile shall be determined as follows: Water absorption, percent by mass =(M_1 - M_2) / M_2x 100 where MI = mass in g of the saturated specimen, and MB = mass in g of the oven-dried specimen.

4. The average value shall be reported.

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 RATES

Rates shall be for the complete finishing work including necessary forms, underbed, sticker and preparation of the surface including cutting and chipping to receive the finish but exclusive of the base unless specially included in Contract.

The dividing strips in case of in situ terrazzo finish shall be included in the rates. Similarly, indentations, laying in desired patterns and in panels shall be inclusive in the rates.

All necessary cutting tiles, slabs, etc. cost of specials if any shall be included in the rates. No extra shall be paid for rounding corners and edges. Unless specifically mentioned otherwise, same rates will apply to floor, skirting, dado, treads, nosing, etc.

5.00.00 METHOD OF MEASUREMENT

The finished surface shall be measured for area. Any opening less than 0.1 Sq.M. (and 0.05 Sq.M. in case of marble finish only) shall not be taken into account neither any extra shall be paid for it.

For terrazzo finish, either in situ or tiled shall be paid at the same rate unless mentioned separately in the schedule of items.

Except in case of in situ terrazzo finish and unless mentioned in the Schedule dividing strips shall be measured in length.

6.00.00 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)

VOLUME : VII-C

SECTION-XXIV

TECHNICAL SPECIFICATION FOR FALSE FLOORING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXIV : 1
2.00.00	FALSE FLOORING SYSTEM	VII-C/S-XXIV : 1
3.00.00	STRENGTH	VII-C/S-XXIV : 2
4.00.00	SURFACE FINISH	VII-C/S-XXIV : 2
5.00.00	SKIRTING	VII-C/S-XXIV : 2
6.00.00	INSTALLATION	VII-C/S-XXIV : 2
7.00.00	METALLIC FALSE FLOORING	VII-C/S-XXIV : 2

VOLUME : VII-C

SECTION-XXIV

TECHNICAL SPECIFICATION FOR FALSE FLOORING

1.00.00 SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

2.00.00 FALSE FLOORING SYSTEM

2.01.01 Base

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

2.01.02 Supporting Structure

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm. centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

2.01.03 Floor Panel

The floor panels shall be made of phenol formaldehyde bonded particleboard treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm. x 600 mm. with all panel edges finished to a tolerance of $\pm$ 0.25 mm. on the diagonals. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05-mm. thick Aluminium foils, which shall be fixed to the particleboard with resin-based adhesive.

3.00.00 **STRENGTH**

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

4.00.00 **SURFACE FINISH**

All removable panels shall have the top surface finished with 2 mm thick Antistatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

5.00.00 **SKIRTING**

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

6.00.00 **INSTALLATION**

All steel surfaces are to be protected by pointing over a primer, as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with Kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

7.00.00 **METALLIC FALSE FLOORING**

7.01.00 **Laminated Panel**

Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of **49 hemispherical and 36 reverse cones** and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the

crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi - automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black **Conductive PVC edge trim** 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

7.02.00 **Sub Structure-Pedestal Assembly**

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of **65 mm to a maximum of 600 mm** from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of leveling and accurately align panels for a maximum of ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement.

The Pedestal head assembly shall consist of a 75 x 75 mm x 3.5 mm embossed head mechanically riveted to a 100mm long 19 mm Dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-irrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 22.20 mm OD pipe of thickness 1.6mm mechanically locked on a press for perpendicularity and then welded to a base plate of 100 x 100 x 2mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

7.03.00 **Stringers**

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x 570 mm length.

PERFORMANCE CONFORMING TO MASTER SPECS 10270 / 096900 (USA)

A. **Structural Performance : CISCA A/F, 'Recommended Test Procedures for Access Floors'**

- **Concentrated Loads**

  540 Kgs (1200 lbf) with a top-surface deflection under load and a permanent set not to exceed , respectively, 2.54 & 0.25 mm (0.10 & 0.010 inch) according to CISCA A/F, Section I '' Concentrated Loads''

- **Ultimate Concentrated Load**

  1350 Kgs (3000 lbf) without failing according to CISCA A/F, Section II '' Ultimate Loading''

- **Rolling Loads**

  270 kgs (600 lbf) of the following magnitude, with a combination of local and overall deformation not to exceed 1.02 mm (0.040 inch) according to CISCA A/F, Section III '' Rolling Loads''

  CISCA AF Rolling Load: 10000 Passes

- **Stringer Load Testing**

  204 Kgs (450 lbf) at the centre of the span with a permanent set not to exceed 0.25mm (0.010 inch) as determined by CISCA A/F, Section IV, '' Stringer Load Testing''

- **Pedestal Axial Load Test**

  22 Kn axial Load per pedestal, according to CISCA A/F, Section V, ''Pedestal Axial Load Test ''

- **Pedestal Over Turning Moment Test**

  113 N x meters, according to CISCA A/F, Section VI, ''Pedestal Overturning Moment Test''

B. **Other Optional Structural Parameters**

- **Floor Panel Impact – Load Performance**

  100 lbf when dropped from 36 inches (914 mm) on to 1-Sq.Inch (6.5 sq.cm) area located anywhere on Panel without failing.

- **Uniformly Distributed Load (UDL)**

  1620 kg/m^2 with a maximum permissible deflection of not more than 1.52 mm as per definition of "Uniform load" of CISCA tested over an area of 300x300 mm square for 100kgs load

Note : The uniform load rating of an access floor panel as specified here in should not be confused with the "uniform live load" as specified in seismic zone application.

C. **Other Non structural Parameters**

- **Fire Rating**

  The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 Part 6 (Fire Propagation) & 7 (Surface spread of flame) as also ASTM E84 1998 (Flammability) and ASTM E136 (Combustibility)

- **Electrical Resistivity**

  As per ASTM F150/ NFPA 99 / ANSI S7.1 but modified for surface to ground to place one electrode on the floor surface and to attach the other electrode on the pedestal. Resistance to be tested at 500 volts

  1. Conductive range : $2.5x10^4$ – $1x\ 10^6$ Ohms (surface to ground)
  2. Static dissipative range : $1x10^6$- $1x10^9$ Ohms (surface to ground)
  3. Anti static range : $1x10^9$ – $2x10^{10}$ Ohms (surface to surface)

- **Fabrication Tolerance**

  A. Floor panel flatness : ± 0.76 mm in any direction

  B. Floor panel width or length from specified size : ± 0.25 mm

  C. Floor panel squareness : ± 0.38 mm

7.04.00 **Acceptance Criteria**

The false flooring system shall be checked specially for :

a) Level

b) Alignment of joints

c) Thickness of joints

d) Surface finish

e) Colour and texture

VOLUME : VII-C

SECTION-XXV

TECHNICAL SPECIFICATION
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXV : 1
2.00.00	INSTALLATION	VII-C/S-XXV : 1
3.00.00	PAINTING	VII-C/S-XXV : 11
4.00.00	PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES	VII-C/S-XXV : 19
5.00.00	PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS	VII-C/S-XXV : 22
6.00.00	PAINTING WITH WOOD PRESERVATIVE	VII-C/S-XXV : 24
7.00.00	COAL TARRING	VII-C/S-XXV : 24
8.00.00	SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE	VII-C/S-XXV : 25
9.00.00	SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE	VII-C/S-XXV : 26
10.00.00	WALL PAINTING WITH PLASTIC EMULSION PAINT	VII-C/S-XXV : 27
11.00.00	PAINTING WITH SYNTHETIC ENAMEL PAINT	VII-C/S-XXV : 28
12.00.00	PAINTING WITH ALUMINIUM PAINT	VII-C/S-XXV : 29
13.00.00	PAINTING WITH ACID PROOF PAINT	VII-C/S-XXV : 30
14.00.00	PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT	VII-C/S-XXV : 30
15.00.00	FLOOR PAINTING	VII-C/S-XXV : 30

CONTENT [Contd ….]

CLAUSE NO.	DESCRIPTION	PAGE NO.
16.00.00	VARNISHING	VII-C/S-XXV : 31
17.00.00	FRENCH SPIRIT POLISHING	VII-C/S-XXV : 34
18.00.00	EPOXY COATING/PAINTING	VII-C/S-XXV : 35
19.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXV : 36
20.00.00	RATES	VII-C/S-XXV : 36
21.00.00	METHOD OF MEASUREMENT	VII-C/S-XXV : 36
22.00.00	I. S. CODES	VII-C/S-XXV : 38

VOLUME : VII-C

SECTION-XXV

TECHNICAL SPECIFICATION FOR PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with lime punning or white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. Contractor shall keep record of number of coats of painting. Before applying second coat, the contractor 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 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.

a) **White Washing**

Preparation of Surface : Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings an foreign matters.

Preparation of Lime wash : The lime wash be prepared from fresh stone white lime (Natural or Dehradun quality) or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS: 712 latest editions and shall be submitted to the Engineer for approval and approved sample shall be brought to site in unslaked condition. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic decimeter of the cream. The approximate quantity of water to be added in making the cream will be 5 liters of water to one kg of lime.

Indigo (Neel) up to 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 liters per kg. of lime to produce a milky solution.

Application: The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next coat is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

Protective Measures : Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

Measurements : Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

Measurements for Jambs, Soffits and Fills etc. for openings shall be as described earlier.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated non-asbestos cement sheet 20%

Semi corrugated non-asbestos cement sheet 10%

Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements.

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared.

The rate shall include all material and labour involved in all the operations described above.

b) **Colour Washing**

The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.

For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface has been prepared (as described above) a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Other specifications as described eallier.

c) **Dry Distemper**

Materials : Dry distemper of required colour (IS 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-Charge before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

Preparation of Surface : Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

New plastered surfaces shall be allowed to dry completely, before applying, distemper.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the resular coat of distemper is applied.

Priming Coat : A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface be allowed to dry before distemper coat is given.

Application : In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface shows an even colour.

For old work, the surface prepared (as described before) shall be applied one or more coats of distemper till the surface attains an even colour.

The application of each coat shall be as follows :

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

The subsequent coats shall be applied only after the previous coat has dried.

The finished surface shall be even and uniform and shall show no brush marks.

Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

After each day's work, the brushes shall be washed in hot water and hang down to dry. Old brushes which are dirty or caked with distemper shall not be used.

The specifications in respect of scaffolding and protective measures shall be as described before.

d) **Oil Emulsion (Oil Bound) Washable Distemper**

Materials

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufactures shall be used. The primers where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of the work, till this item of work has been completed and passed by the Engineer-in-Charge.

Preparation of the Surface

For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing & scrubbing. The surface shall then be allowed to dry for that 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.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described before.

Note: If the wall surface plastered has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surface if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint confirming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hang down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures shall be as described before.

e) **Cement Primer Coat**

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

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 uneveness 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 : The cement primer shall be applied with a brush on the clean dry 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. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

The specifications in respect of scaffolding, protective measures shall be as described before.

f) **Cement Paint**

Material : The cement Paint shall be (confirming to IS 5410) of approved brand and manufacturer.

The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of the Surface : For new work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly.

Preparation of Mix : Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought to in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application : The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The salutation shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the days work.

The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

Precaution : Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces.

If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

The specifications in respect of scaffolding and protective measures shall be as described before. The coefficient for cement paint on RCC Jalli shall be 2 x (for painting all over).

g) **Exterior Painting on Wall**

Material : The paint shall be (Textured exterior paint / Acrylic smooth exterior paint / premium acrylic smooth exterior paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained form 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.

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 contractor 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 contractor 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 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.

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.

Measurements

The length and breadth shall be measured correct to a cm. The area shall be calculated in the sqm. (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sqm. irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table 1
Equivalent Plain Areas of Uneven surface

Sl. No.	Description of Work	How measured	Multiplying Coefficients
I.	**Wood Work Doors, Windows etc.**		
1.	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	1.30 (for each side)
3.	Flush doors etc.	. --- do ---	1.20 (for each side)
4.	Part paneled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	. --- do ---	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	. --- do ---	1.80 (for each side)
7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2.00 (for painting all over)
8.	Carved or enriched work	Measured flat	2.00 (for each side)
9.	Weather boarding	Measured flat (not girthed supporting frame work) shall not be measured separately	1.20 (for each side)
10.	Wood single roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.08 (for painting all over)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
II.	**Steel Work Doors, Windows etc.**		
13.	Plane sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (Excluding painting of wire gauze portion)	. --- do ---	0.50 (for each side)
15.	Part paneled and partly glazed or gauzed doors and windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	. --- do ---	1.25 (for each side)
17.	Collapsible gates	. --- do ---	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat	1.10 (for each side)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
III.	**General**		
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1.00 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	. --- do --- (See note no. 12)	1.00 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	. --- do --- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	. --- do ---	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plane sheets	. --- do ---	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	. --- do ---	1.00 (for each side)

Explanatory Notes for Table 1

1. Measurement for doors windows etc., shall be taken flat (and not girthed) over all including chowkhuts or frames, where provided. Where Chowkhuts or frames are not provided, the shutter measurements shall be taken.

2. Where doors, windows etc., are of composite types, different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

3. The coefficients for doors and windows shall apply irrespective of the size of frames and shutter members.

4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

5. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

6. In the case where shutters are fixed on both faces of the frames, the measurement for he door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.

7. Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.

8. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel vertical. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.

9. Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings etc.

10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

11. The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

12. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisade do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top standards when the letter are higher than the top rails or the palisades.

Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sqm. and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

Precautions

All furnitures, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damages done shall be made good by the contractor at his cost.

Rate
Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items

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.

Table-2

Sl. No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer confirming to IS 3585
3.	(A) Aluminium and light alloys	Zinc chromate primer confirming to IS 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer confirming IS 2074
4.	Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer confirming to IS 109

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 woo 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 red oxide zinc chromate 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 (which shall be paid for separately) is to be applied after placing the member in position and just before applying Paint. The second coat of primer is not necessary in case of painting with synthetic enamel Paint as it is applied over and under coat of ordinary Paint.

Painting Priming Coat On Wood, Iron Or Plastered Surfaces

Synthetic Enamel

Paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S sheets shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

Preparation of Surface

Painting New Surface : The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm. of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

Painting Old 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 number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

5.00.00 PAINTING CAST IRON 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 in the description of the item.

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.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

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.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

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 'Distempering 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 uneveness 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 WALL PAINTING WITH PLASTIC EMULSION PAINT

The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

Plastic emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, morter 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 commended.

Application : 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.

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 SYNTHETIC ENAMEL PAINT

Synthetic Enamel Paint (confirming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an under coat of ordinary Paint of shade to match the top coat as recommended by the same manufacture as far the top coat shall be used.

Painting on New Surface

Preparation of Surface *:* Preparation of surface shall be as specified in 4.01.00 as the case may be.

Application : The number of coats including the undercoat shall be as stipulated in the item.

a) **Under Coat :** One coat of he specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

b) **Top Coat:** Top coat of synthetic enamel Paint of desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

Other details shall be as specified in 'EXTERIOR PAINTING ON WALL' as far as they applicable.

Painting on Old Surface

Preparation of Surface : Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old Paint is blistered and flaked it will be necessary to completely remove. Such removal shall be paid for separately and the painting shall be treated as on new surface.

Painting : The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

12.00.00 PAINTING WITH ALUMINIUM PAINT

Aluminium Paint shall be (confirming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

Preparation of Surface

Steel Work (New Surfaces) : All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

C.G.S. Sheets (New Surfaces) : The preparation of surface shall be as specified in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting New Surface'.

Steel Work or C.G.S. Sheets (Old Surfaces) : The specifications shall be as described in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting Old Surface'.

Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

13.00.00 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 under 11.00.00 for new/old surface as the case may be.

Other details shall be as specified in 3.00.00 as far as they applicable

14.00.00 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 13.32 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 3.00.00 as far as applicable.

15.00.00 FLOOR PAINTING

Floor Paint of approved brand and manufacture and of the required colour shall be used.

Preparation of Surface

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacture and rubbed smooth.

It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old.

Old surface shall be prepared as specified in 'PAINTING WITH SYNTHETIC ENAMAL PAINT, Painting on Old Surface, Preparation of Surface'.

Application

The number of coats as in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

16.00.00 **VARNISHING**

Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

Varnish (confirming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

Varnishing on New Surfaces

Preparation of Surface : New wood work to be varnished shall have been finished smooth with a carpenter's plan. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

Sizing or Transparent Wood Filler Coat : The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

a) **Sizing :** When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any jointing up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household untensils which are likely to disturb the size coatings and thus expose bare wood.

Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

b) **Transparent Wood Filler Coat :** Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described earlier, shall be given as application of the application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

Application of Varnish : The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhance the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, letter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnished shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and dump air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Varnishing on Old Surface

Preparation of Old Surface : If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in ‘Varnishing on New Surfaces, Preparation of Surface’. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish and such removal shall be paid for separately outside the rate for varnishing. Future the varnishing itself will have to be done like new work and will be paid for as such.

Application : The specification shall be same as described in ‘Application of Varnish’ as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

Other details shall be as specified in 3.00.00 as far as they are applicable.

17.00.00 **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 given 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 damped 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 3.00.00 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 do 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 3.00.00 as far as they are applicable.

18.00.00 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.

18.01.00 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.

18.02.00 **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 spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

19.00.00 **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.

20.00.00 **RATES**

Rates shall be unit rates for complete items described in the Schedule of Items. No extra payment will be made for preparation of surface before painting or for cleaning up after the work is complete.

21.00.00 **METHOD OF MEASUREMENT**

a) All structural steelwork whose any or all faces are to be painted shall be measured and paid according to Table-1.

b) Painting or whitewashing to concrete or masonry shall be measured and on the area painted. For measurement of openings whose jambs, sills, soffits etc. are to be painted the following procedure shall be followed:

i) For openings up to 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings and no additions shall be made for jambs, sills, etc.

ii) For openings exceeding 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings, and no additions shall be made for jambs, sills etc.

iii) For openings exceeding 3.0 sq.m. each, deductions shall be made for the whole area, and additions shall be made for the jambs, sills soffits, reveals etc.

c) For openings, pipes, sleeves etc. whose sides are not finished no deductions shall be made for openings etc. upto 0.1 sq.m. in area each and full deductions shall be made for all openings above 0.1 sq.m. in area each.

d) No extra shall be paid for painting etc. done around openings, sleeves, pipes, ducts, inserts, etc.

e) No extra payment shall be made for painting, etc. on wall features such as grooves, ducts, beads, projections, cornices, etc. unless give different finish or otherwise specified in the "Schedule of Items". The actual area of the features shall be girthed and included in the wall measurements.

f) For painting of uneven surfaces in doors, windows, ventilators, louvers, guard bars, balustrades, gratings, railings, gates, etc. equivalent plain areas shall be measured as given in Clause 17.2 (Table II) of IS:1200.

g) Corrugated surfaces shall be measured flat as fixed and not girthed. The quantities as measured shall be multiplied by the following factors to get equivalent plain area :

i) Corrugated steel sheets - shall be multiplied by 1.14.

ii) Corrugated asbestos sheets with large corrugations shall be multiplied by 1.20

iii) Semi-corrugated asbestos cement sheets shall be multiplied by 1.10.

iv) Any other non-standard corrugated surfaces shall be measured as decided by the Engineer.

h) For painting pipes for sanitary and plumbing work, measurement shall be made on actual work done in R.M. for different diameters. Measurements shall be along the central lines of pipes laid. No deductions or additions shall be made for valves, fittings, etc.

i) Unless specifically stated on the schedule of items, all painting, varnishing or polishing of wood shall be measured and paid on the area treated. For measurement of uneven surfaces, equivalent Main area shall be measured as per Clause 17.2 (Table II) of IS: 1200.

22.00.00 **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.

VOLUME : VII-C

SECTION-XXVI

TECHNICAL SPECIFICATION FOR SUSPENDED CEILING

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXVI : 1
2.00.00	INSTALLATION	VII-C/S-XXVI : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXVI : 5
4.00.00	RATES	VII-C/S-XXVI : 5
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XXVI : 5
6.00.00	I. S. CODES	VII-C/S-XXVI : 6

VOLUME : VII-C

SECTION-XXVI

TECHNICAL SPECIFICATION FOR SUSPENDED CEILING

1.00.00 SCOPE

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, plaster of paris boards. Perspex etc. together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or 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 walls, slabs and beams or trusses.

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 securely fixed to walls. All drillings of structural concrete or welding to steel for installation 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. All wood supports shall be painted with two coats of “Solignum” or other approved wood preservative before erection.

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 approved equal. Steel grid ceiling system shall be snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 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.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

2.01.03 **Timber Grid Suspension System**

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pre-treated teakwood batten grid suspended in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties call 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 the following types :

a) Plaster of Paris boards

b) Expanded polystyrene insulation boards

c) Fibre insulation boards

d) Wood particle boards

e) Glass fibre reinforced polystyrene sheets

f) Glass Reinforced Gypsum Board / Gypsum Board or Tiles

g) Mineral Fibre Board

h) Aluminium Panel – Linear / square / plank type false ceiling

i) Calcium silicate Board or tiles

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvers etc. shall be from approved manufacturers and in thickness specified in schedule.

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling 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 begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.03.00 **False ceiling systems with different materials**

2.03.01 **Glass Reinforced Gypsum (GRG) or Gypsum Moisture Resistant Tiles / Board**

1. Load bearing galvanized light gauge sections shall be used for supporting of (seamless) finished ceiling. G.I. channels of size 0.55 mm thickness having one flange of 300 mm. and a web of 27 mm. shall be fixed along with perimeter of ceiling, screw fixed to brick wall/ partition with the help of nylon sleeves & screws at 610 mm centres. Then suspending G.I. intermediate channels of size 45 mm. 0.9 mm. thick with two flanges of size 15 mm. each from the soffit at 1200 mm centres with ceiling angle of width 25 mm X 25 mm X 0.55 mm thick fixed to soffit with G.I. cleat and steel expansion fastner. Ceiling section of 0.55 mm thickness having knurled web of 51.5 mm and two flanges of 26 mm each with lips of 10.5 mm are then fixed to the intermediate channel with the help of connecting clips and in direction perpendicular to the intermediate channel at 457 mm centres. 12 mm thick GRG/Gyp MR Board is then screw fixed to ceiling sections with 25 mm dry wall screws at 230 mm centres. The board shall be joined and finished to have a flush look.

2. For profiled and curved surface, supporting structure from galvanized steel shall be made in required shape. Board shall be formed in to the curved shape while wet before fixing.

2.03.02 **Mineral Fibre Board**

For laying Mineral Fibre Board in tile of 600 mm X 600 mm the supporting grid system shall be formed by light gauged galvanized steel T- sections. Supporting grid system shall be rolled formed double web galvanized tees and shall meet the requirements of ASTM C-635. Nominal size of T-section shall be 24x38 mm for main runner. Exposed flange surface i.e. 24 mm wide shall be precoated or provided with a matching coloured cap. Main supporting section shall be suspended from RCC soffit / steel member with 4 mm dia galvanized rod & spring steel clip @ 1200 mm c/c. Suspensions from RCC shall be taken using expansion fasteners. The main supporting member shall be placed @ 1200 cross T-sections is inserted into the slots provided in main supporting member at 600 mm c/c so as to give a maximum size of 1200 mm x 600 mm.

Mineral Fibre Board Tiles shall be laid onto the grid 4 nos. of PVC holding clips shall be provided for each panel.

Aluminium Panels – Linear / Square tiles (lay-in or lay-on type) / planks

Aluminium panel ceiling, perforated or un-perforated as per requirement, of approved make, colour consisting of panel 150 mm wide x 15.5 mm deep x 0.5 mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 5050(Al.mg) for higher strength and good roll forming characteristics. The Panels about each other with a narrow V grove. Panel shall be clipped to a baked enamelled Aluminium Panel carrier of 32 mm wide x 39 mm deep x 0.95 mm thick in standard length of 5 mtr made of double baked enamelled Aluminium alloy AA 5050 (Al.mg) black with cut-outs to hold the panels in a module of 150 mm closed at a distance 1.00 mtr. Panel carrier shall be suspended by means of G.I. suspension rod 4-mm diameter and a Galvanised suspension spring clip at a distance of 1.7 mtr c/c. Paint Finish: Aluminium Panels shall be chromatised for maximum bond between metal and paint enamelled twice under high temperature, one side with a full primer and finish coat the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.

Or tile of 600mm wide and 600mm long manufactured out of 0.7mm thick Aluminium alloy AA 5050(Al.mg). Tile ends will be raised with pips and stops to ensure positive engagement into the spring to enable for de-mounting of individual panels. The Tile sides will be sufficiently high to ensure a minimum deflection across the length of Tile. All Tiles will be bevel edged. The Tile shall be Polyester based, powder coated in white colour. The Tile shall be clipped into clip in profile of 0.5mm thick G.I. The clip in profile shall be supported from slab by means of rigid suspension of 4mm G.I. Rod, Hold on Clamp with Clip. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.
Or 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. 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 12mm dia 50mm long anchor bolts 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 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 RATES

Shall be unit rates for complete items called for in the “Schedule of Items”. No extra payment will be made for arrangement for lighting fixtures air conditioning diffusers access panels, etc. The rate shall include all cutting and wastage from standard size sheets boards, runners, etc.

5.00.00 METHOD OF MEASUREMENT

a) Actual area of work done shall be measured.

b) No deduction will be made for opening upto 0.25 sq. metre in area each

c) Where a rigid steel framework is required to support the ceiling, it shall be measured and paid separately under relevant item in the Schedule.

6.00.00 I. S. CODES

IS: 2441 - Code of Practice for fixing ceiling coverings.

VOLUME : VII-C

SECTION-XXVII

TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDE WALL

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXVII : 1
2.00.00	INSTALLATION	VII-C/S-XXVII : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXVII : 8
4.00.00	RATES	VII-C/S-XXVII : 8
5.00.00	METHOD OF MEASUREMENT	VII-C/S-XXVII : 8
6.00.00	I. S. CODES	VII-C/S-XXVII : 9

VOLUME : VII-C

SECTION-XXVII

TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDE WALL

1.00.00 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet plain /corrugated/trough covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc., as shown on drawings and schedule of items.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

This shall be of the thickness specified in the description of the item and shall conform to IS 277. The sheets shall be of 275 grade of coating unless otherwise specified in the description of item.

The sheet shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposit on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

Purlins : Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters and the spacing will be as specified in the drawing.

Slope : Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal or as specified in the drawing. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

Laying and Fixing : The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridges, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Lapping in C.G.I. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.I. sheet, before the sheets are fixed in place.

Sheet shall not generally be fixed in to gables and parapets. They shall be bent up along their side edges close to the wall and junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the Purlins or other roof members such as hip or valley rafters etc. with galvanized J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washers filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron Purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete Purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

The galvanized coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanized coating should conform to IS 1367 9pt. XIII). The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of coating

Minimum Mass (g/m^2	Average Thickness(µm)	Minimum Mass (g/m^2)	Individual Thickness(µm)
375	54	300	43

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt provided with bitumen and a G.I. limpet washers or a G.I. limpet washers filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

Finish : The roof when completed shall be true to lines, and slopes and shall be leak proof.

Measurements : The length and breadth shall be measured correct to cm. Area shall be worked out in sq.m. correct to two places of decimal.

The specified area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

Roof with curved sheets shall be measured and paid separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening up to 0.4sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

Rate : The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.I. sheets. This includes the cost the cost of roof sheets, galvanized iron J or L hooks, bolts and nuts, galvanized iron seam bolts and nuts, bituminous and galvanized iron limpet washers etc.

Ridges and Hips of Plain Galvanised Steel Sheets

Ridges and Hips : Ridges and hips of C.G.I. roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.I. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.I. sheet, 0.6mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.`

Fixing : Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

Surface of C.G.I. sheets of ridge and hip sections and roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.I. sheets before they are fixed in place.

Finish : The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

Measurement : The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.

Rate : The rate shall include the cost of all labour and materials specified above, including painting, cost of seam bolts and any extra G.I. hook bolts, nuts and washers, required.

Valley and Flashing of Plain Galvanised Steel Sheets

Valley and Flashing : Valley shall be 90 cm wide overall plain G.I. sheet 1.6 mm thick or other size as specified in the item bent to shape and fixed. They shall lap with the C.G.I. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain G.I. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not less than 25 cm.

Laying and Fixing : Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonry with the mortar of mix 1:3 (1cement: 3 coarse sand).

Surface of G.I. sheets under overlaps shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.I. sheets.

Finish : The edges of valley and flushing should be straight from end to end. The surface should be true and without bulges and depressions.

Measurements : The length of the valleys and flashing shall be measured for the finished work correct to a cm. The laps along the length of the valley or flashing pieces, including the portion embedded in masonry, shall not be measured.

Rates : The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of seam bolts and the cost of requisite G.I. hook bolts, nuts and washers required over and above those needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost of boarding underneath which shall be paid for separately.

The rate for flashing shall be for all the labour and materials specified above, and shall include the cost of painting and mortar for fixing in wall.

Gutters Made of Plain Galvanised Steel Sheets

Gutters : Gutter shall be fabricated from plain G.I. sheets of thickness as specified in the item

Eaves gutters shall be of the shape and section specified in the description in the item. The overall width of the sheet referred to their in shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form rounded edges. The ends of the sheets at junction of pieces shall be hooked in to each other and beaten flush to avoid leakage.

Slope : Gutters shall be laid with a minimum slope of 1 in 120.

Laying and fixing : Gutters shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers.

Where the brackets are to be fixed to the purlins, the bracket shall consist of 50 x 3 mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 nos. of 10 mm diameter bolts, nuts and washers. The bracket will be stiffened by provision of 50 x 3 mm M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 no. 10 mm dia bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

The gutter shall be fixed to the brackets with 2 nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.I. sheet of the same thickness as the gutter and reverted to the gutter, the other end tailing in to the socket of the rain-water pipe. Wherever stop ends, angles etc., should be provided.

Finish : The gutters when fixed shall be true to line and slope and shall be leak proof.

Measurements : Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured.

Rate : The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing latter to the roof members. Brackets of 50 x 3 mm flats fixed to purlins with stiffener flats will be paid extra.

2.02.03 **Fiber Glass Reinforced Plastic Sheeting**

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

2.02.04 **Precoated metal sheet**

Precoated metal sheeting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.

Thermally insulated sandwiched metal cladding for external facade shall be of approved manufacturer. Sheeting shall Hi Rib 0.5 mm troughed sheeting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluro polymer (PV F2 or equivalent) and shall have life span sustenance against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.

Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 m W/cm deg C (at 50 degree C) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part

14) including sealants, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthling.

2.02.04 **Polycarbonate Sheeting Work**

Solid Polycarbonate sheet of minimum 4mm thick should be of UV resistant and high temperature resistant. Sheet should be of approved brand and quality, colour and transparency for ceiling/ roofing on plain, sloped, curved surfaces to any pitch or height including fixing purlins with polymer quoted galvanized self drilling, self tampering metal screws and fasteners and EPDM washers, rubber gasket with closing caps, adequate adhesive and sealants as per manufacturer's specification etc. complete but excluding the cost of purlins, rafters, trusses etc.(if any). Polycarbonate sheets shall be uniform pigmentation and thickness with out air pockets and shall conform to IS: 14443: 1997 and including cutting to required length and size including profile machine bending of sheets to achieve the desired profile by conforming minimum joints and laps as per drawing.

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 **RATES**

Rates shall be for unit rate for complete item described in the Schedule and shall include all wastages as mentioned earlier.

5.00.00 **METHOD OF MEASUREMENT**

a) No allowance shall be made for laps.

b) Roofing and side sheeting shall be measured for net area of work done. Corrugated sheeting shall be measured flat and not girthed. Openings less than 0.4 Sq.m shall not be deducted. Detailed stated earlier.

c) Special features like flashings, ridge pieces, caves, corner pieces, north-light curves etc. shall be measured for length of installation.

d) Gutter and down comers shall be measured for length along their centre lines and bends, junctions, shoes ends, etc. shall not be paid properly.

e) S-type asbestos louvers shall be measured for area of opening in which it is installed.

f) Curved asbestos roofing sheets shall be measured for area of curve.

g) Asbestos ventilators, roof lights shall be measured and paid under relevant items.

6.00.00 **IS CODES**

The following are some of the important IS Codes relevant to these sections:

IS : 3007	:	Code of practice for laying of asbestos cement sheets
IS : 2527	:	Code of practice for fixing rain water gutters and down pipes for roof drainage
IS : 1626	:	Specification for asbestos cement building pipes gutters and fittings
IS : 277	:	Specification for galvanised steel sheets (plain and corrugated)
IS : 1200 (PT.IX)	:	Method of measurements of building and civil engineering works: Part – 9 Roof covering (including cladding)
IS : 2633	:	Method of testing uniformity of coating on zinc coated articles.
IS : 3144	:	Method of test for mineral wool thermal insulation materials.
IS : 3346	:	Method of the determination of thermal conductivity of thermal insulation materials.
IS : 8183	:	Bonded mineral wool

VOLUME : VII-C

SECTION-XXVIII

TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXVIII : 1
2.00.00	INSTALLATION	VII-C/S-XXVIII : 1
3.00.00	ACCEPTANCE CRITERIA	VII-C/S-XXVIII : 9
4.00.00	I. S. CODES	VII-C/S-XXVIII : 9

VOLUME : VII-C

SECTION-XXVIII

TECHNICAL SPECIFICATION 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.

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.

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 them 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 Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.03.01 **Foam Concrete**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.03.02 **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/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision.

Material: Expanded polystyrene shall conform to IS 4671. It is of two types given below :

Type N-Normal

Type SE – It shall be of self extinguishing type when tested in accordance with IS 4671.

Dimensions : The size of the finished boards shall be 1.0 x 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100mm.

Tolerance : The tolerances on the length, width and thickness of the finished board shall be ± mm.

Requirements for Expanded Polystyrene for General Use :

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
1.	Thermal conductivity (k. value) (a) at 0ºC (b) at 10ºC	 0.34 0.37	 0.32 0.35	 0.30 0.33	 0.29 0.32	 0.28 0.30	 IS 3346
2.	Compressive strength at 10% deformation in kg/sq.cm Minimum.	0.7	0.9	1.1	1.4	1.7	IS 4671

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
3.	Cross breaking strength in kg/sq.cm Minimum.	1.4	1.6	1.8	2.2		IS 4671
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671
6.	Water absorption	Less than 0.5% by volume (after 24 hrs. immersion)					IS 4671

Sampling : In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judgment conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table given below. The sample shall be taken at random from the lot.

No. of items in the lot	No. of sample items	Permissible number of defective sample items
1	2	3
Up to 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

General : Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled ober the suspended false ceiling.

Measurements : Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of area up to 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

Rate : The rate shall include the cost of material and labour in providing and fixing the polystyrene boards.

2.03.03 **With Resin Bonded Fiber Glass Wool (Bonded Mineral Wool)**

Material : The material shall be mineral wool made from sock slag or glass processed from a molten state in to fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall be 25, 40, 50, conform to specifications of group I of IS 8183.

Dimensions : The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded material wool shall be 25, 40, 50, 65 or 75 mm.

Tolerance : For width and length, the dimensional tolerance of the bonded material wool shall be -1/2 %. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

Requirements for Fiber Glass Wool

Sl. No.	Characteristics	Group I	Test Reference
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	Not less than 90% of original thickness	Annexure. A of IS 3144
3.	Shot content max	500 micron-5% 250micron-15%	IS 8183
4.	Moisture content and absorption	Not more than 2%	IS 3144
5.	In combustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg. C	0.49 mw/ cmºC	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

General : Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

Measurements : Length and breadth of roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas up to 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in areas, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surface in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

Rate : The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

Either of above items (cl. No. 2.3.1 or 2.3.2 or 2.3.3) can be adopted subject to approval of engineer.

2.04.00 **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 by volume.

2.05.00 **Water proofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, and light traffic. The application shall be resistant to growth of fungus and proof against saltpeter action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.06.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.07.00 **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 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.

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/m°K 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 exposed to sun.

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.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner. Any bad work or any damage to the treatment shall be repaired and made good by the contractor at his own cost.

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.

VOLUME : VII-C

SECTION-XXIX

TECHNICAL SPECIFICATION
FOR
WATER SUPPLY

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	VII-C/S-XXIX : 1
2.00.00	INSTALLATION	VII-C/S-XXIX : 6
3.00.00	TESTING AND ACCEPTANCE	VII-C/S-XXIX : 13
4.00.00	RATES	VII-C/S-XXIX : 14
5.00.00	MEASUREMENT	VII-C/S-XXIX : 14
6.00.00	I. S. CODES	VII-C/S-XXIX : 16

VOLUME : VII-C

SECTION-XXIX

TECHNICAL SPECIFICATION FOR WATER SUPPLY

1.00.00 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

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 contractor, 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 contractor. Nothing extra shall be paid for it, except where otherwise specified.

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 or 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 Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order 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) Cast Iron

b) Steel: lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Asbestos Cement

f) Lead (Not to be used for potable water)

g) P. V. C.

h) Copper

i) Brass

j) Wrought iron

k) Galvanized Iron- heavy & medium duty pipes- is 1239 & is 4736

l) PP-R Pipes – IS 15801

1.03.00 **Water Tanks**

Water tanks shall be made of PVC, HDPE, MS pressed steel, GI, Concrete masonry. PVC/HDPE/Pressed Steel tanks 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 Contractor 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 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. The fee paid to the Authorities shall be reimbursed by the Owner.

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 Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 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 Pipings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **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 Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **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) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degrees of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **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.

d) **Asbestos Cement Pipes**

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

e) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

f) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

g) **P. V. C. / UPVC/ HDPE/PP-R**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

h) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 **Painting**

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.02.00 **Storage Tank - Pressed Steel Tank**

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.02.01 **G. I. Water Tank**

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.

In case it is desired by the Engineer that corners of tank should be welded instead of riveted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.02.02 **Polythene Water Storage Tanks**

Material

Polythene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) 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 toxity 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 of 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

Rates

The rate shall include the cost of the tank. Manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

2.02.03 **Tube Wells with Hand Pumps**

Casing Pipe

The casing pipe shall be of M.S. or W.I. of 100 mm dia. And strong enough to stand hammering and vibrations to which it is subjects.

Filter and Brass Strainer

The filter shall consist of a G.I. pipe of the required diameter with 15 mm diameter holes covered with brass strainer both inside and outside. It shall have a driving point riveted or welded to it.

Hand Pump

This shall be of approved quality. It shall be complete with necessary bolt and nuts for jointing to the masonry or concrete base.

2.03.00 **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 in the Schedule. Nominal size and material shall be as per schedule.

2.04.00 **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/CM^2 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 **RATES**

Rates shall be unit rates for the complete work as mentioned in the specification unless any particular portion is specifically excluded in the Schedule of Items.

If any material, fittings or fixtures are provided by the Owner f ree, the Contractor shall have to take delivery, keep in safe custody and be responsible till fitted and handed over.

5.00.00 **MEASUREMENT**

For method of measurement regarding works under scope of the specification IS: 1200 (Part-XVI) latest edition shall be followed unless contrary to the following:

5.01.00 **Trenches**

Unless particular items are included in the schedule, no separate measurement shall be made to lead, lift, dewatering, dressing, storing, backfilling, consolidation etc. that may be required in this connection.

5.02.00 **Concrete Masonry**

The measurement shall be on gross area or volume basis as mentioned under the relevant items.

5.03.00 **Soling**

No separate measurement should be made for dressing and ramming the surface. The soling shall be measured on gross area of the work under the item.

5.04.00 **Pipe Works**

No separate measurement shall be made for specials, supports and fixtures, cutting chases, holes and rectification unless specially indicated in the Schedule of Items. If the specials are separately indicated in the Schedule, the measurement for these shall be over and above the measurement of the pipe work as mentioned below :

The pipes of different nominal bores shall be measured separately.

The pipe work shall be measured in length inclusive of sockets, specials, fittings etc. in position.

5.05.00 **Fittings and Fixtures**

Measurement for fittings and fixtures where applicable shall be in number. No separate measurement shall be made for anchors unless they form a separate item in the Schedule.

5.06.00 **Chases, Holes**

If items for cutting and remaking of chases, holes and similar works are included in the Schedule the measurement shall be on gross length, area or volume as appropriate.

5.07.00 **Painting**

Painting pipe works shall be measured on the basis of length for different nominal diameters of the pipes. Painting of steel work may be on the basis of weight or area or otherwise as mentioned against the particular items.

6.00.00 **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
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 polythylene 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)

VOLUME : VII-C

SECTION-XXX

TECHNICAL SPECIFICATION FOR DRAINAGE AND SANITATION

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	V-IIC/S-XXX : 1
2.00.00	INSTALLATION	V-II-C/S-XXX : 1
3.00.00	TESTING AND ACCEPTANCE	V-IIC/S-XXX : 15
4.00.00	RATES	V-IIC/S-XXX : 17
5.00.00	MEASUREMENT	V-IIC/S-XXX : 17
6.00.00	I. S. CODES	V-IIC/S-XXX : 19

VOLUME : VII-C

SECTION-XXX

TECHNICAL SPECIFICATION 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 public sewer or to treatment work, septic tank and soak pit dispersion trenches.

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 downcomers shall be standard Cast Iron, UPVC, and 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 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**

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 shed 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.

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.

UPVC rain water/ soil pipe shall of the dia, specified in the description of the item and shall be in nominal lengths of 2, 3, 4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerance on specified length shall be + 10mm and – 0 mm.

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. This process is repeated while joining PVC material to CI/AC materials.

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.

Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. including or excluding all fittings along its length as stated/described in the BOQ.

2.01.02 **Cement concrete pipes (with and without Reinforcement) (Light Duty, Non-Pressure)**

The pipes shall be with or without reinforcement as required and shall be of class not less than NP2. These shall conform to IS: 458. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

2.01.03 **Cast Iron (Centrifugally cast) Pipes and Specials**

The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be cast iron cast centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure specified in the IS Code.

Specials : The special shall conform to IS 1538. The hydraulic test pressure of each class shall be as detailed mentioned in the IS Code.

2.01.04 **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 batches, 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 A.C. 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 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.

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. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be hunched.

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.

Laying Of Cement Concrete Pipes : Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least $1/4^{th}$ of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up to the sides of the pipe at least to a distance of $1/4^{th}$ of the outside diameter of pipes 300 mm and over a dia. The pipe shall be laid in this concrete bedding before the concrete has set.

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**

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. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) **Cast Iron Pipes**

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) **Concrete Pipes**

Care shall be taken to place the collar centrally over the joint.

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 of 1:1 proportion. Then the socket is filled, 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 covered with damp cloth or other suitable materials.

d) **Vitrified clay pipes**

These 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, Specification for Building 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 and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) **Lead Pipes**

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) **Polyethylene Pipes**

The joints shall be thermo-welded or bolted as per manufacturer's instructions.

g) **Jointing Cast Iron Pipes with Stoneware Pipes**

Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp 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 fiber.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) **Raised type**

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level 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 desired by the Engineer.

b) **Squatting type**

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with 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. The flushing cistern shall be painted as desired by the Engineer.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.05.03 **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.

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 Contractor.

2.06.00 **Septic tank & effluent disposal**

2.06.01 **Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia. Whose top shall be provided with a suitable mosquito proof 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.

2.06.02 **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.

2.06.03 **Soak pit**

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.06.04 **Open joined SW Pipe / dispersion trenches**

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. 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.

2.06.05 **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.

3.00.00 **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.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazed ware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) **For straightness**

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end 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 **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.

3.04.00 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 **RATES**

Rates shall be unit rates for the complete work as detailed out in the Specification unless any particular portion is specifically excluded in the Schedule of Items.

If any material fittings or fixtures are provided by the Owner free, the Contractor shall have to take delivery, keep in safe custody and be responsible till fitted and handed over.

5.00.00 **MEASUREMENT**

For method of measurement regarding work under scope of this Specification IS: 1200 (Part-XVI) shall be followed unless contrary to the following:

5.01.00 **Trenches**

Unless particular items are included in the Schedule, no separate measurement shall be made for lead, lift, dewatering, dressing, storing, backfilling consolidation etc. that may be required in this connection.

5.02.00 **Concrete, masonry**

Unless lumped with other items in the Schedule the measurement shall be on gross area or volume basis as mentioned under relevant items.

5.03.00 **Pipe work**

No separate measurement shall be made for special supports and fixtures, cutting chases, holes and rectification unless specially indicated in the Schedule of Items. If the specials are separately indicated in the Schedule, the measurement for these shall be over and above the measurement, of the pipe work as mentioned below:

The pipes of different nominal bores shall be measured separately. The pipe work shall be measured in length inclusive of sockets specials, fittings etc. in position.

5.04.00 **Fittings and fixtures**

Measurement for fittings and fixtures where applicable shall be in number for the complete item inclusive of anchors, brackets and fasteners required. However, in special cases anchors, brackets and similar items may be measured separately if included as such in the Schedule of Items.

5.05.00 **Chases and holes**

No measurement shall be made for cutting chases, holes etc. and making good for any work within the scope of this specification and shall be inclusive.

5.06.00 **Painting**

All items likely to rust shall be painted with one coat of primer which shall not be measured separately. Where finishing coat of paints are supplied that shall be measured as indicated in the Schedule of Items. Usually, painting of pipes shall be measured in length for each different nominal diameter without giving any extra allowance for specials sockets, etc.

5.07.00 **Septic tank, Soak pit**

Usually it shall be measured in number for the complete septic tank or soak pit as per drawing. All earthwork, backfilling masonry, concrete, manhole, pipes and fittings included. In case, it is intended to pay for individual items the same shall be indicated in the Schedule and measured in number, length, area or volume as appropriate.

6.00.00 **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.

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 (Part 1) - 'P' & 'S' traps.

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.
	-	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.

TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL

1.0.0 SCOPE

This specification shall generally be read in conjunction with item nos. 6.01 & 6.03.

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described.

2.0.0 INSTALLATION

2.1.0 Fabrication/Casting

2.1.1 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.1.2 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel.

b) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.1.3 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer.

2.2.0 Erection

2.2.1 **Bracing**

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.2.2 Temporary Bolting-Up

As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.2.3 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.2.4 Welding

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

2.2.5 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.2.6 Drifting

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

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.2.7 Grouting

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the

Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

2.2.8 Anchor Bolting

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.2.9 Pipe Joints

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.2.10 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

2.2.11 Making Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

3.0.0 ACCEPTANCE CRITERIA

a) All items shall be of correct shape, size, weight etc. shown on drawings.

b) For installed items, the tolerances shall be follows :

i) Permissible deviation from straightness - 1 in 1000.

ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blow holes, cracks and other blemishes.

4.0.0 I.S. CODES

IS : 226 - Structural Steel (Standard Quality)

IS:800 - Code of practice for use of structural steel in general building construction.

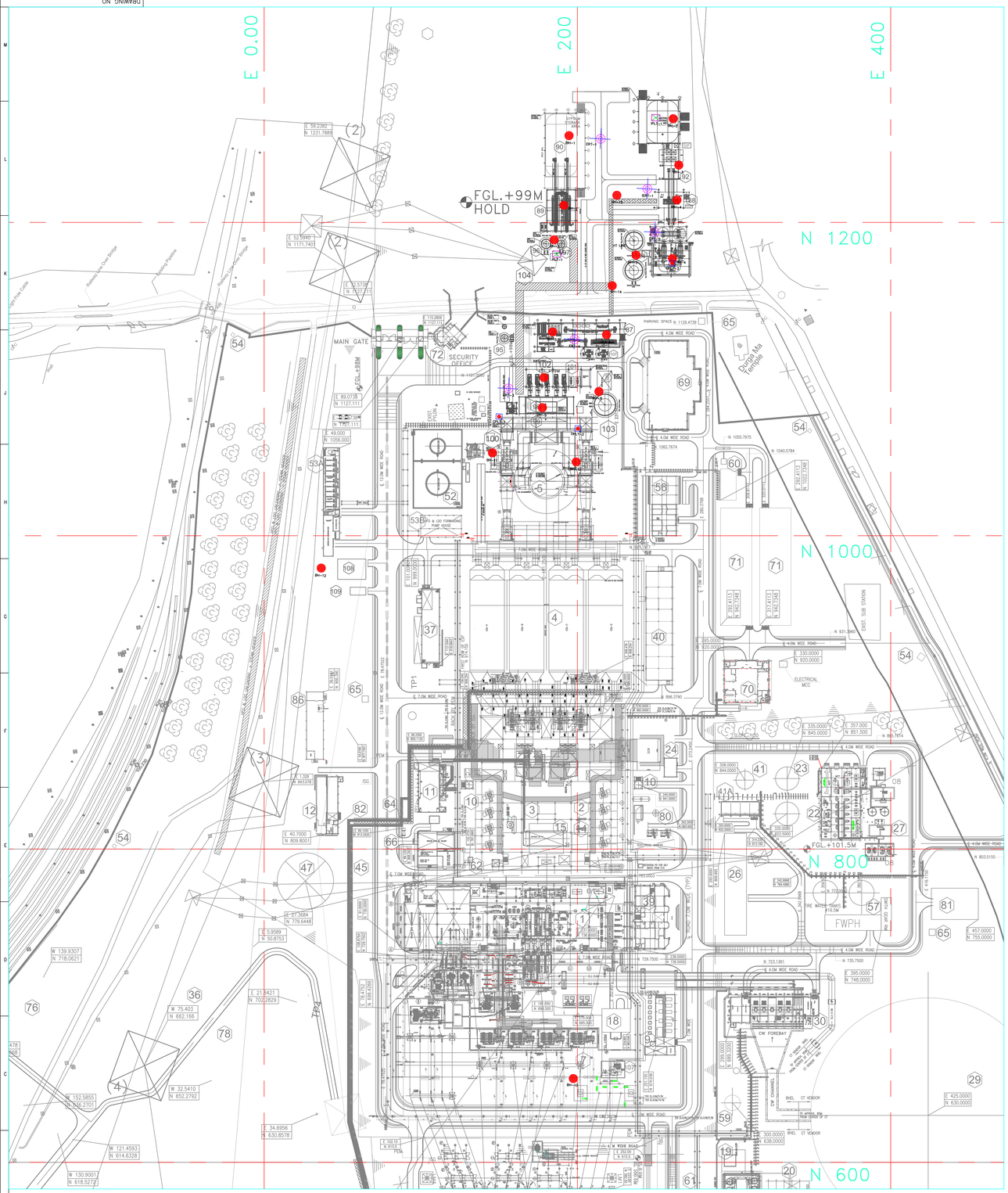
IS : 816 - Use of metal arc welding for general construction in mild steel.

IS : 2812 - Arc welding of Aluminium and Alloys

IS : 3150 - Hexagonal Wire Netting

IS : 4948 - Welded steel wire fabric for general use.

COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED
it must not be used directly or indirectly in any way detrimental to the interest of the company.


E 0.00
E 200
E 400
N 1200
N 1000
N 800
N 600
FGL.+99M HOLD
FGL.+99M
FGL.+101.5M
MAIN GATE
SECURITY OFFICE
Durga Ma Temple
FWPH
ELECTRICAL MCC
EXIST. SUB STATION
CW FOREBAY
CW CHANNEL
BHEL CT VENDOR
PARKING SPACE N 1129.4739
4.0M WIDE ROAD
7.0M WIDE ROAD
E 59.2582 N 1031.7888
E 52.5940 N 1171.7401
E 27.5139 N 1127.711
E 89.0738 N 1127.111
E 89.000 N 1056.000
E 49.000 N 1007.111
E 115.2809 N 1127.111
E 40.7000 N 809.8001
E 27.3684 N 779.6448
E 5.9589 N 50.8753
E 21.8421 N 702.2829
E 34.6956 N 630.8578
W 139.9307 N 718.0621
W 75.403 N 662.166
W 32.5410 N 652.2792
W 152.5855 N 536.2701
W 121.4593 N 614.6328
W 130.9007 N 618.5272
E 425.0000 N 630.0000
E 457.0000 N 755.0000
E 395.0000 N 748.0000
E 335.0000 N 845.0000
E 357.000 N 851.500
E 330.0000 N 920.0000
E 295.0000 N 920.0000
E 300.0000 N 638.0000
E 335.0000 N 803.0000
E 308.0000 N 844.0000
E 729.7500 N 735.7500
E 723.1361 N 735.7500
E 1292.5113 N 942.7348
E 1317.4113 N 942.7348
E 1055.7975
E 1040.5784
E 1062.7674
E 1280.7398
E 1299.0000 N 1055.0000
E 1316.0000 N 1055.0000
E 1335.0000 N 1055.0000
E 1354.0000 N 1055.0000
E 1373.0000 N 1055.0000
E 1392.0000 N 1055.0000
E 1411.0000 N 1055.0000
E 1430.0000 N 1055.0000
E 1449.0000 N 1055.0000
E 1468.0000 N 1055.0000
E 1487.0000 N 1055.0000
E

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	20.00 M	JOB NO :- SA-1053	BORE HOLE NO:-01 / SHEET NO:-01
COMMENCED ON :-19.08.2021	COMPLETED ON :-21.08.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-189.00 N:-1207.00 / RL:-97.011M
WATER TABLE:- 1.10 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP	0.00	0.00		0.50			DS	01			
			1.00		1.00			UDS	01			
		1.50										
			2.00		2.00		32	SPT	01			
COARSE SAND	SP		3.00		3.00		40	SPT	02			
			4.00		4.00		58	SPT	03			
		4.50										
			5.00		5.00		>100	SPT	04			
			6.00		6.00		>100	SPT	05			
SOFT SAND STONE	VERY DENSE		7.00		7.00			CS	01	8	NIL	
			8.00		8.00			CS	02	11	NIL	
			9.00		9.00			CS	03	7	NIL	
			10.00		10.00			CS	04	9	NIL	
		11.00	11.00		11.00			CS	05	14	NIL	
			12.00		12.00			CS	06	19	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE		13.00		13.00			CS	07	21	NIL	
			14.00		14.00			CS	08	20	NIL	
			15.00		15.00			CS	09	25	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-01 No. of CORE :-14 No. of S.P.T. :-05	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-19.08.2021	COMPLETED ON :-21.08.2021
WATER TABLE:- 1.10 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-01 | SHEET NO:-02

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-189.00 N:-1207.00 | RL:-97.011M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE	15.00	15.00		15.00			CS	09	25	NIL	
		16.00	16.00		16.00			CS	10	29	11	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		17.00		17.00			CS	11	33	12	
			18.00		18.00			CS	12	37	13	
			19.00		19.00			CS	13	44	12	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	14	51	22	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-01 No. of CORE :-14 No. of S.P.T. :-05	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-22.08.2021	COMPLETED ON :-24.08.2021
WATER TABLE:- 0.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-02 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-184.00 N:-1186.00 | RL:-97.286M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
		0.00	0.00									
					0.50			DS	01			
			1.00		1.00			UDS	01			
CLAYEY SOIL	SC											
			2.00		2.00		13	SPT	01			
			3.00		3.00			UDS	02			
		3.50										
			4.00		4.00		48	SPT	02			
MOORUM	SP											
			5.00		5.00		54	SPT	03			
		5.50										
			6.00		6.00		>100	SPT	04			
			7.00		7.00			CS	01	5	NIL	
SOFT SAND STONE	VERY DENSE											
			8.00		8.00			CS	02	3	NIL	
			9.00		9.00			CS	03	7	NIL	
		10.00	10.00		10.00			CS	04	12	NIL	
			11.00		11.00			CS	05	15	NIL	
			12.00		12.00			CS	06	11	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE											
			13.00		13.00			CS	07	17	NIL	
			14.00		14.00			CS	08	21	NIL	
			15.00		15.00			CS	09	24	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-02	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-14	No. of Water Sample :-NIL
	No. of S.P.T. :- 04	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-22.08.2021	COMPLETED ON :-24.08.2021
WATER TABLE:- 0.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-02 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-184.00 N:-1186.00 | RL:-97.286M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	09	24	NIL	
			16.00		16.00			CS	10	31	11	
			17.00		17.00			CS	11	35	NIL	
			18.00		18.00			CS	12	36	15	
			19.00		19.00			CS	13	44	21	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	14	49	15	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-02	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-14	No. of Water Sample :-NIL
	No. of S.P.T. :- 04	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-25.08.2021	COMPLETED ON :-27.08.2021
WATER TABLE:- 0.60 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-03 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-236.00 N:-1178.00 | RL:-97.413M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
		0.00	0.00									
					0.50			DS	01			
CLAYEY SOIL	SC		1.00		1.00			UDS	01			
		1.50										
			2.00		2.00		54	SPT	01			
			3.00		3.00		72	SPT	02			
MOORUM	SP											
			4.00		4.00		>100	SPT	03			
								DS	02			
		5.00	5.00		5.00		>100	SPT	04			
			6.00		6.00			CS	01	NIL	NIL	
SOFT SAND STONE	VERY DENSE		7.00		7.00			CS	02	NIL	NIL	
			8.00		8.00			CS	03	4	NIL	
			9.00		9.00			CS	04	6	NIL	
		9.50										
			10.00		10.00			CS	05	10	NIL	
			11.00		11.00			CS	06	13	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE		12.00		12.00			CS	07	15	NIL	
			13.00		13.00			CS	08	18	NIL	
		14.00	14.00		14.00			CS	09	23	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		15.00		15.00			CS	10	25	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02	No. of Undisturbed sample:-01	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 15	No. of Water Sample :-NIL
	No. of S.P.T. :- 04	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DIA OF HOLE -	150MM/NX	JOB NO :- SA-1053	BORE HOLE NO:-03 / SHEET NO:-02
DEPTH -	20.00 M		
COMMENCED ON :-25.08.2021	COMPLETED ON :-27.08.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-236.00 N:-1178.00 / RL:-97.413M
WATER TABLE:- 0.60 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	10	25	NIL	
			16.00		16.00			CS	11	29	NIL	
			17.00		17.00			CS	12	35	NIL	
			18.00		18.00			CS	13	37	NIL	
			19.00		19.00			CS	14	43	NIL	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	15	48	NIL	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-01 No. of CORE :- 15 No. of S.P.T. :- 04	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	20.00 M	JOB NO :- SA-1053	BORE HOLE NO:-04 / SHEET NO:-01
COMMENCED ON :-27.08.2021	COMPLETED ON :-28.08.2021	LOCATION :-KTPS, PALONCHA	PLANT CO-ORDINATES: E:-259.00 N:-1177.00 / RL:-97.420M
WATER TABLE:- 0.50 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
		0.00	0.00									
					0.50			DS	01			
			1.00		1.00			UDS	01			
CLAYEY SOIL	SC											
			2.00		2.00			UDS	02			
		3.00	3.00		3.00		49	SPT	01			
MOORUM	SP											
			4.00		4.00		63	SPT	02			
		4.50										
			5.00		5.00		>100	SPT	03			
SOFT SAND STONE	VERY DENSE		6.00		6.00			CS	01	NIL	NIL	
			7.00		7.00			CS	02	5	NIL	
		8.00	8.00		8.00			CS	03	7	NIL	
			9.00		9.00			CS	04	13	NIL	
			10.00		10.00			CS	05	12	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE		11.00		11.00			CS	06	15	NIL	
			12.00		12.00			CS	07	17	NIL	
		13.00	13.00		13.00			CS	08	22	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		14.00		14.00			CS	09	25	NIL	
			15.00		15.00			CS	10	27	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-02	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-15	No. of Water Sample :-NIL
	No. of S.P.T. :- 03	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-27.08.2021	COMPLETED ON :-28.08.2021
WATER TABLE:- 0.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-04 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-259.00 N:-1177.00 | RL:-97.420M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
		15.00	15.00		15.00			CS	10	27	NIL	
		16.00	16.00		16.00			CS	11	31	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		17.00		17.00			CS	12	34	NIL	
			18.00		18.00			CS	13	39	NIL	
			19.00		19.00			CS	14	44	NIL	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	15	48	NIL	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-02	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-15	No. of Water Sample :-NIL
	No. of S.P.T. :- 03	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-13.07.2021	COMPLETED ON :-15.07.2021
WATER TABLE:- 1.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-05 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-186.00 N:-1127.00 | RL:-98.713M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.50			0.50			DS	01			
			1.00		1.00		32	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		38	SPT	02			
			3.00		3.00		39	SPT	03			
		3.50										
			4.00									
					4.50		39	SPT	04			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00			DS	02			
		6.00	6.00									
			7.00		7.00		52	SPT	05			
MEDIUM TO COARSE SAND	SP				7.50			DS	03			
			8.00		8.00		60	SPT	06			
		8.50										
			9.00		9.00		>100	SPT	07			
SOFT DISINTEGRATED ROCK	DENSE		10.00		10.00		>100	SPT	08			
					10.50			DS	04			
			11.00		11.00		>100	SPT	09			
	VERY DENSE TO VERY DENSE	11.50										
			12.00									
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK					12.50			CS	01	20	NIL	
			13.00									
					13.50			CS	02	25	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK		14.00	14.00									
					14.50			CS	03	32	NIL	
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 09	No. of Water Sample :-NIL
	No. of S.P.T. :- 09	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-13.07.2021	COMPLETED ON :-15.07.2021
WATER TABLE:- 1.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-05 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-186.00 N:-1127.00 | RL:-98.713M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.50			CS	04	37	12	
			16.00		16.50			CS	05	40	13	
			17.00		17.50			CS	06	42	14	
			18.00		18.50			CS	07	43	16	
			19.00		19.50			CS	08	44	18	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	09	46	20	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 09 No. of S.P.T. :- 09	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	8.50 M
COMMENCED ON :-13.07.2021	COMPLETED ON :-14.07.2021
WATER TABLE:- 1.20 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-06 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-220.00 N:-1127.00 | RL:-98.728M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00		0.50			DS	01			
		0.60	1.00		1.00		31	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		43	SPT	02			
			3.00		3.00		62	SPT	03			
		3.50	4.00		4.00			CS	01	35	15	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		5.00		5.00			CS	02	44	22	
			6.00		6.00			CS	03	51	31	
			7.00		7.00			CS	04	57	44	
			8.00		8.00			CS	05	64	52	
BH TERMINATED AT THE DEPTH OF 8.50M		8.50			8.50			CS	06	68	59	
			9.00									
			10.00									
			11.00									
			12.00									
			13.00									
			14.00									
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,

▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 06	No. of Water Sample :-NIL
	No. of S.P.T. :- 03	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	4.00 M
COMMENCED ON :-05.09.2021	COMPLETED ON :-06.09.2021
WATER TABLE:- 1.00 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053

BORE HOLE NO:-BH-6A (CONFORMATIC BORE HOLE)

SHEET NO:-01

LOCATION :-KTPS, PALONCHA

PLANT CO-ORDINATES: E:-220.00 N:-1131.50

RL:-98.804M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.50			0.50			DS	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES			1.00		1.00		>100	SPT	01			▽
		2.00	2.00		2.00			CS	01	64	58	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK			3.00		3.00			CS	02	68	62	
BH TERMINATED AT THE DEPTH OF 4.00M		4.00	4.00									
			5.00									
			6.00									
			7.00									
			8.00									
			9.00									
			10.00									
			11.00									
			12.00									
			13.00									
			14.00									
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-NIL	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 02	No. of Water Sample :-NIL
	No. of S.P.T. :- 01	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-19.07.2021	COMPLETED ON :-21.07.2021
WATER TABLE:- 1.45 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-07 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-182.00 N:-1103.00 | RL:-99.103M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00		0.00							
		0.50			0.50			DS	01			
			1.00		1.00		27	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		32	SPT	02			
			3.00		3.00		34	SPT	03			
		4.00	4.00		4.00		38	SPT	04			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00		43	SPT	05			
					5.50			DS	02			
			6.00		6.00		45	SPT	06			
		6.50										
			7.00		7.00		51	SPT	07			
COARSE SAND WITH BOULDER	SP				7.50			DS	03			
			8.00		8.00		55	SPT	08			
		9.00	9.00		9.00		>100	SPT	09			
SOFT DISINTEGRATED ROCK	DENSE		10.00		10.00		>100	SPT	10			
					10.50			DS	04			
			11.00		11.00		>100	SPT	11			
	VERY DENSE TO VERY DENSE	12.00	12.00		12.00		>100	SPT	12			
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK			13.00		13.00			CS	01	22	NIL	
		13.50										
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK			14.00		14.00			CS	02	27	NIL	
			15.00		15.00			CS	03	35	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 08	No. of Water Sample :-NIL
	No. of S.P.T. :- 12	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-19.07.2021	COMPLETED ON :-21.07.2021
WATER TABLE:- 1.45 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-07 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-182.00 N:-1103.00 | RL:-99.103M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	03	35	NIL	
			16.00		16.00			CS	04	36	10	
			17.00		17.00			CS	05	38	15	
			18.00		18.00			CS	06	41	18	
			19.00		19.00			CS	07	44	20	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	08	46	25	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 08	No. of Water Sample :-NIL
	No. of S.P.T. :- 12	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-16.07.2021	COMPLETED ON :-18.07.2021
WATER TABLE:- 1.60 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-08 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-217.00 N:-1093.00 | RL:-99.018M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.40			0.50			DS	01			
			1.00		1.00		31	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		34	SPT	02			
			3.00		3.00		42	SPT	03			
		3.50										
			4.00		4.00		50	SPT	04			
					4.50			DS	02			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00		57	SPT	05			
			6.00		6.00		61	SPT	06			
		7.00	7.00		7.00		>100	SPT	07			
			8.00		8.00			DS	03			
SOFT DISINTEGRATED ROCK	DENSE		9.00									
			10.00		10.00			DS	04			
		10.50										
			11.00									
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		12.00		11.50			CS	01	15	NIL	
			13.00		12.50			CS	02	17	NIL	
		13.50			13.50			CS	03	20	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		14.00		14.50			CS	04	24	NIL	
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 10	No. of Water Sample :-NIL
	No. of S.P.T. :- 07	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-16.07.2021	COMPLETED ON :-18.07.2021
WATER TABLE:- 1.60 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-08 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-217.00 N:-1093.00 | RL:-99.018M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	05	28	NIL	
			16.00		16.00			CS	06	32	NIL	
			17.00		17.00			CS	07	41	10	
			18.00		18.00			CS	08	42	26	
			19.00		19.00			CS	09	44	25	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	10	47	20	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 10 No. of S.P.T. :- 07	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	30.00 M
COMMENCED ON :-19.07.2021	COMPLETED ON :-22.07.2021
WATER TABLE:- 1.75 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-09 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-182.00 N:-1079.00 | RL:-99.148M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.30			0.50			DS	01			
			1.00		1.00		26	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		29	SPT	02			
			3.00		3.00		34	SPT	03			
		4.00	4.00		4.00		36	SPT	04			
					4.50			DS	02			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00		39	SPT	05			
			6.00		6.00		41	SPT	06			
		6.50										
			7.00		7.00		46	SPT	07			
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP				7.50			DS	03			
			8.00		8.00		50	SPT	08			
		8.50										
			9.00		9.00		>100	SPT	09			
SOFT DISINTEGRATED ROCK	DENSE		10.00		10.00			DS	04			
		11.00	11.00									
			12.00		12.00			CS	01	12	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		13.00		13.00			CS	02	15	NIL	
			14.00		14.00			CS	03	17	NIL	
			15.00		15.00			CS	04	20	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 19 No. of S.P.T. :- 09	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	30.00 M
COMMENCED ON :-19.07.2021	COMPLETED ON :-22.07.2021
WATER TABLE:- 1.75 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-09 | SHEET NO:-02

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-182.00 N:-1079.00 | RL:-99.148M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	04	20	NIL	
			16.00		16.00			CS	05	21	NIL	
			17.00		17.00			CS	06	24	NIL	
			18.00		18.00			CS	07	26	NIL	
			19.00		19.00			CS	08	30	NIL	
			20.00		20.00			CS	09	32	NIL	
			21.00		21.00			CS	10	34	NIL	
			22.00		22.00			CS	11	36	NIL	
			23.00		23.00			CS	12	38	10	
			24.00		24.00			CS	13	41	12	
			25.00		25.00			CS	14	43	15	
			26.00		26.00			CS	15	44	17	
			27.00		27.00			CS	16	41	20	
			28.00		28.00			CS	17	45	25	
			29.00		29.00			CS	18	45	26	
BH TERMINATED AT THE DEPTH OF 30.00M		30.00	30.00		30.00			CS	19	48	28	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 19	No. of Water Sample :-NIL
	No. of S.P.T. :- 09	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DIA OF HOLE -	150MM/NX	JOB NO :- SA-1053	BORE HOLE NO:-10 / SHEET NO:-01
DEPTH -	20.00 M		
COMMENCED ON :-16.07.2021	COMPLETED ON :-18.07.2021	LOCATION :-KTPS, PALONCHA	PLANT CO-ORDINATES: E:-205.00 N:-1052.00 / RL:-99.258M
WATER TABLE:- 1.05 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.40			0.50			DS	01			
			1.00		1.00		23	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		32	SPT	02			
			3.00		3.00		41	SPT	03			
		3.50										
			4.00		4.00		51	SPT	04			
					4.50			DS	02			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00		56	SPT	05			
			6.00		6.00		58	SPT	06			
		6.50			6.50			DS	03			
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP		7.00		7.00		60	SPT	07			
		8.00	8.00		8.00		>100	SPT	08			
			9.00		9.00							
SOFT DISINTEGRATED ROCK	DENSE		10.00		10.00			DS	04			
		11.00	11.00		11.00							
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE TO VERY DENSE		12.00		12.00			CS	01	15	NIL	
			13.00		13.00			CS	02	22	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK		14.00	14.00		14.00			CS	03	25	NIL	
			15.00		15.00			CS	04	35	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 09	No. of Water Sample :-NIL
	No. of S.P.T. :- 08	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-16.07.2021	COMPLETED ON :-18.07.2021
WATER TABLE:- 1.05 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-10 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-205.00 N:-1052.00 | RL:-99.258M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	04	35	NIL	
			16.00		16.00			CS	05	41	10	
			17.00		17.00			CS	06	42	11	
			18.00		18.00			CS	07	47	15	
			19.00		19.00			CS	08	49	18	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	09	51	21	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 04 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 09 No. of S.P.T. :- 08	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-22.07.2021	COMPLETED ON :-24.07.2021
WATER TABLE:- 1.50 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-11 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-152.00 N:-1053.00 | RL:-99.293M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00		0.50			DS	01			
		0.60	1.00		1.00		23	SPT	01			
MOORUM WITH LITTLE SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		25	SPT	02			
			3.00		3.00		30	SPT	03			
		4.00	4.00		4.00		34	SPT	04			
					4.50			DS	02			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC		5.00		5.00		38	SPT	05			
		6.00	6.00		6.00		45	SPT	06			
					6.50			DS	03			
MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		7.00		7.00		48	SPT	07			
		7.50										
			8.00		8.00		53	SPT	08			
					8.50			DS	04			
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP		9.00		9.00		55	SPT	09			
		9.50										
			10.00		10.00		>100	SPT	10			
			11.00		11.00			DS	05			
SOFT DISINTEGRATED ROCK	DENSE		12.00		12.00			DS	06			
	DENSE TO VERY DENSE		13.00									
		14.00	14.00									
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK			15.00		15.00			CS	01	20	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 06	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 06	No. of Water Sample :-NIL
	No. of S.P.T. :- 10	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	20.00 M	JOB NO :- SA-1053	BORE HOLE NO:-11 / SHEET NO:-02
COMMENCED ON :-22.07.2021	COMPLETED ON :-24.07.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-152.00 N:-1053.00 / RL:-99.293M
WATER TABLE:- 1.50 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE DENSE TO VERY DENSE	15.00	15.00		15.00			CS	01	20	NIL	
			16.00		16.00			CS	02	25	NIL	
		16.50	17.00		17.00			CS	03	30	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK			18.00		18.00			CS	04	38	NIL	
			19.00		19.00			CS	05	44	22	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	06	48	28	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 06	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 06	No. of Water Sample :-NIL
	No. of S.P.T. :- 10	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	20.00 M	JOB NO :- SA-1053	BORE HOLE NO:-12 / SHEET NO:-01
COMMENCED ON :-23.07.2021	COMPLETED ON :-25.07.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-48.00 N:-971.00 / RL:-99.539M
WATER TABLE:- 1.20 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	CI	0.00	0.00		0.50			DS	01			
			1.00		1.00		22	SPT	01			
		1.50										
			2.00		2.00		26	SPT	02			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC				2.50			DS	02			
			3.00		3.00		32	SPT	03			
		3.50										
			4.00		4.00		40	SPT	04			
					4.50			DS	03			
MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		5.00		5.00		44	SPT	05			
		5.50										
			6.00		6.00		52	SPT	06			
COARSE SAND	SP				6.50			DS	04			
		7.00	7.00		7.00		>100	SPT	07			
			8.00		8.00			DS	05			
SOFT DISINTEGRATED ROCK	DENSE											
			9.00									
		9.50										
			10.00		10.50			CS	01	10	NIL	
			11.00		11.50			CS	02	12	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		12.00		12.50			CS	03	14	NIL	
			13.00		13.50			CS	04	18	NIL	
			14.00		14.50			CS	05	20	NIL	
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 05	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 11	No. of Water Sample :-NIL
	No. of S.P.T. :- 07	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-23.07.2021	COMPLETED ON :-25.07.2021
WATER TABLE:- 1.20 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-12 | SHEET NO:-02

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-48.00 N:-971.00 | RL:-99.539M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.50			CS	06	25	NIL	
			16.00		16.50			CS	07	27	NIL	
			17.00		17.50			CS	08	32	NIL	
			18.00		18.50			CS	09	40	NIL	
			19.00		19.50			CS	10	42	18	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	11	45	22	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 05	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 11	No. of Water Sample :-NIL
	No. of S.P.T. :- 07	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-25.07.2021	COMPLETED ON :-27.07.2021
WATER TABLE:- 1.00 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-13 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-223.00 N:-658.00 | RL:-97.092M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.45			0.50			DS	01			
			1.00		1.00		25	SPT	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		30	SPT	02			
			3.00		3.00		32	SPT	03			
		3.50										
			4.00		4.00		35	SPT	04			
SANDY CLAY WITH SMALL AMOUNT PEBBLES /COBBLES	SC				4.50			DS	02			
			5.00		5.00		38	SPT	05			
		5.50										
			6.00		6.00		42	SPT	06			
SILT SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP				6.50			DS	03			
		7.00	7.00		7.00		46	SPT	07			
			8.00		8.00		49	SPT	08			
					8.50			DS	04			
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP		9.00		9.00		51	SPT	09			
			10.00		10.00		56	SPT	10			
		9.50										
			11.00		11.00		>100	SPT	11			
SOFT DISINTEGRATED ROCK	DENSE		12.00		12.00			DS	05			
			13.00		13.00			DS	06			
			14.00									
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE	14.50										
			15.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 06	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 06	No. of Water Sample :-NIL
	No. of S.P.T. :- 11	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-25.07.2021	COMPLETED ON :-27.07.2021
WATER TABLE:- 1.00 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-13 | SHEET NO:-02

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-223.00 N:-658.00 | RL:-97.092M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE TO VERY DENSE	15.00	15.00		15.50			CS	01	10	NIL	
		16.00	16.00		16.50			CS	02	15	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK			17.00		17.50			CS	03	25	NIL	
			18.00		18.50			CS	04	35	19	
			19.00		19.50			CS	05	45	20	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	06	49	28	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 06 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 06 No. of S.P.T. :- 11	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-01.09.2021	COMPLETED ON :-02.09.2021
WATER TABLE:- 0.70 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-14 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-233.391 N:-1164.795 | RL:-97.686M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SAMPLE DEPTH IN MTRS.	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
CLAYEY SOIL	SC	0.00	0.00	0.50		DS	01			
			1.00	1.00		UDS	01			
		1.50	2.00	2.00	47	SPT	01			
MOORUM	SP					DS	02			
			3.00	3.00	64	SPT	02			
		4.00	4.00	4.00	>100	SPT	03			
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE		5.00	5.00		CS	01	08	NIL	
			6.00	6.00		CS	02	10	NIL	
			7.00	7.00		CS	03	11	NIL	
			8.00	8.00		CS	04	13	NIL	
		9.00	9.00	9.00		CS	05	17	NIL	
			10.00	10.00		CS	06	19	NIL	
			11.00	11.00		CS	07	23	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		12.00	12.00		CS	08	27	NIL	
			13.00	13.00		CS	09	31	11	
			14.00	14.00		CS	10	32	10	
			15.00	15.00		CS	11	35	15	

GRAPHICAL REPRESENTATION OF 'N' VALUES (20, 40, 60, 80, 100)

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 03	No. of Undisturbed sample:-01	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-16	No. of Water Sample :-NIL
	No. of S.P.T. :-03	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-01.09.2021	COMPLETED ON :-02.09.2021
WATER TABLE:- 0.70 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-14 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-233.391 N:-1164.795 | RL:-97.686M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	11	35	15	
			16.00		16.00			CS	12	37	NIL	
			17.00		17.00			CS	13	41	21	
			18.00		18.00			CS	14	43	15	
			19.00		19.00			CS	15	46	NIL	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	16	49	16	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02	No. of Undisturbed sample:-01	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-16	No. of Water Sample :-NIL
	No. of S.P.T. :-03	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-28.08.2021	COMPLETED ON :-29.08.2021
WATER TABLE:- 1.30 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-15 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-222.00 N:-1215.00 | RL:-97.490M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.30			0.50			DS	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		1.00		1.00			UDS	01			
		1.50										
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP		2.00		2.00		27	SPT	01			
		3.00	3.00		3.00		51	SPT	02			
			4.00		4.00		>100	SPT	03			
SOFT SAND STONE	VERY DENSE		5.00		5.00		>100	SPT	04			
			6.00		6.00			CS	01	NIL	NIL	
			7.00		7.00			CS	02	4	NIL	
		8.00	8.00		8.00			CS	03	9	NIL	
			9.00		9.00			CS	04	11	NIL	
			10.00		10.00			CS	05	13	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		11.00		11.00			CS	06	18	NIL	
			12.00		12.00			CS	07	21	NIL	
		13.00	13.00		13.00			CS	08	25	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		14.00		14.00			CS	09	27	NIL	
			15.00		15.00			CS	10	29	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,

▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-15	No. of Water Sample :-NIL
	No. of S.P.T. :- 04	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-28.08.2021	COMPLETED ON :-29.08.2021
WATER TABLE:- 1.30 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-15 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-222.00 N:-1215.00 | RL:-97.490M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	10	29	NIL	
			16.00		16.00			CS	11	30	NIL	
			17.00		17.00			CS	12	32	NIL	
			18.00		18.00			CS	13	37	NIL	
			19.00		19.00			CS	14	41	NIL	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	15	44	NIL	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-15	No. of Water Sample :-NIL
	No. of S.P.T. :-04	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	20.00 M	JOB NO :- SA-1053	BORE HOLE NO:-IBH-01 / SHEET NO:-01
COMMENCED ON :-16.08.2021	COMPLETED ON :-18.08.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-190.00 N:-1251.00 / RL:-97.407M
WATER TABLE:- 0.80 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP	0.00	0.00		0.50			DS	01			
			1.00		1.00			UDS	01			
		1.50										
			2.00		2.00		33	SPT	01			
			3.00		3.00		44	SPT	02			
COARSE SAND	SP		4.00		4.00		56	SPT	03			
			5.00		5.00		63	SPT	04			
		6.00	6.00		6.00		>100	SPT	05			
SOFT SAND STONE	VERY DENSE		7.00		7.00		>100	SPT	06			
		8.00	8.00		8.00			CS	01	12	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	VERY DENSE		9.00		9.00			CS	02	9	NIL	
		10.00	10.00		10.00			CS	03	13	NIL	
			11.00		11.00			CS	04	15	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		12.00		12.00			CS	05	21	NIL	
			13.00		13.00			CS	06	19	NIL	
			14.00		14.00			CS	07	24	NIL	
			15.00		15.00			CS	08	27	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-01 No. of CORE :-13 No. of S.P.T. :-06	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	20.00 M
COMMENCED ON :-16.08.2021	COMPLETED ON :-18.08.2021
WATER TABLE:- 0.80 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-IBH-01 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-190.00 N:-1251.00 | RL:-97.407M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	08	27	NIL	
			16.00		16.00			CS	09	35	12	
			17.00		17.00			CS	10	44	15	
			18.00		18.00			CS	11	39	NIL	
			19.00		19.00			CS	12	52	16	
BH TERMINATED AT THE DEPTH OF 20.00M		20.00	20.00		20.00			CS	13	49	12	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 01	No. of Undisturbed sample:-01	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :-13	No. of Water Sample :-NIL
	No. of S.P.T. :- 06	

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	15.00 M
COMMENCED ON :-10.08.2021	COMPLETED ON :-12.08.2021
WATER TABLE:- 0.80 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-IBH-02 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-225.00 N:-1265.00 | RL:-97.494M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SAMPLE DEPTH IN MTRS.	'N' VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY%	RQD%	G.W.L OBSER
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP	0.00	0.00	0.50		DS	01			
		1.00	1.00	1.00	31	SPT	01			
				1.50		DS	02			
COARSE SAND	SP		2.00	2.00	53	SPT	02			
		3.00	3.00	3.00	>100	SPT	03			
			4.00	4.00		CS	01	8	NIL	
SOFT SAND STONE	VERY DENSE		5.00	5.00		CS	02	11	NIL	
			6.00	6.00		CS	03	12	NIL	
		7.00	7.00	7.00		CS	04	20	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		8.00	8.00		CS	05	23	NIL	
			9.00	9.00		CS	06	34	NIL	
		10.00	10.00	10.00		CS	07	37	NIL	
			11.00	11.00		CS	08	39	NIL	
			12.00	12.00		CS	09	43	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		13.00	13.00		CS	10	52	NIL	
			14.00	14.00		CS	11	59	NIL	
BH TERMINATED AT THE DEPTH OF 15.00M		15.00	15.00	15.00		CS	12	60	NIL	

GRAPHICAL REPRESENTATION OF 'N' VALUES (20, 40, 60, 80, 100)

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 12 No. of S.P.T. :- 03	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	25.00 M	JOB NO :- SA-1053	BORE HOLE NO:-IBH-03 / SHEET NO:-01
COMMENCED ON :-13.08.2021	COMPLETED ON :-16.08.2021	LOCATION :-KTPS, PALONCHA	PLANT CO-ORDINATES: E:-260.00 N:-1236.00 / RL:-97.888M
WATER TABLE:- 1.10 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
		0.00	0.00									
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		1.00		0.50			DS	01			
					1.00		24	SPT	01			
		1.50										
			2.00		2.00		39	SPT	02			
COARSE SAND	SP				2.50			DS	02			
			3.00		3.00		48	SPT	03			
		3.50										
			4.00		4.00		>100	SPT	04			
SOFT SAND STONE	VERY DENSE		5.00		5.00			CS	01	7	NIL	
			6.00		6.00			CS	02	9	NIL	
		7.00	7.00		7.00			CS	03	18	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		8.00		8.00			CS	04	24	NIL	
			9.00		9.00			CS	05	27	NIL	
			10.00		10.00			CS	06	31	NIL	
		11.00	11.00		11.00			CS	07	34	NIL	
			12.00		12.00			CS	08	39	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE		13.00		13.00			CS	09	41	15	
			14.00		14.00			CS	10	44	21	
		15.00	15.00		15.00			CS	11	46	25	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 21 No. of S.P.T. :- 04	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING		
DIA OF HOLE -	150MM/NX	CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED	
DEPTH -	25.00 M	JOB NO :- SA-1053	BORE HOLE NO:-IBH-03 / SHEET NO:-02
COMMENCED ON :-13.08.2021	COMPLETED ON :-16.08.2021	LOCATION :- KTPS, PALONCHA	PLANT CO-ORDINATES: E:-260.00 N:-1236.00 / RL:-97.888M
WATER TABLE:- 1.10 M			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	11	46	25	
			16.00		16.00			CS	12	49	22	
			17.00		17.00			CS	13	51	24	
			18.00		18.00			CS	14	54	26	
			19.00		19.00			CS	15	58	30	
			20.00		20.00			CS	16	61	31	
			21.00		21.00			CS	17	62	33	
			22.00		22.00			CS	18	65	37	
			23.00		23.00			CS	19	66	38	
			24.00		24.00			CS	20	68	41	
BH TERMINATED AT THE DEPTH OF 25.00M		25.00	25.00		25.00			CS	21	71	43	
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 21 No. of S.P.T. :- 04	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

SWAYIN & ASSOCIATES

77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	30.00 M
COMMENCED ON :-30.08.2021	COMPLETED ON :-01.09.2021
WATER TABLE:- 1.10 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-IBH-04 | SHEET NO:-01

LOCATION :-KTPS, PALONCHA | PLANT CO-ORDINATES: E:-260.00 N:-1214.00 | RL:-96.898M

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	'N' VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
FILLING SOIL WITH SMALL AMOUNT PEBBLES /COBBLES		0.00	0.00									
		0.40			0.50			DS	01			
CLAYEY MOORUM WITH SMALL AMOUNT PEBBLES /COBBLES	SP		1.00		1.00			UDS	01			▽
		2.00	2.00		2.00		40	SPT	01			
					2.50			DS	02			
COARSE SAND WITH SMALL AMOUNT PEBBLES /COBBLES	SP		3.00		3.00		54	SPT	02			
		3.50										
			4.00		4.00		>100	SPT	03			
			5.00		5.00		>100	SPT	04			
SOFT SAND STONE	VERY DENSE		6.00		6.00			CS	01	NIL	NIL	
			7.00		7.00			CS	02	NIL	NIL	
			8.00		8.00			CS	03	4	NIL	
		9.00	9.00		9.00			CS	04	10	NIL	
			10.00		10.00			CS	05	12	NIL	
COMPLETELY WEATHERED, LIGHT BROWNISH, WEATHERED ROCK	DENSE TO VERY DENSE		11.00		11.00			CS	06	11	NIL	
			12.00		12.00			CS	07	15	NIL	
			13.00		13.00			CS	08	18	NIL	
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	14.00	14.00		14.00			CS	09	22	NIL	
		15.00	15.00		15.00			CS	10	27	NIL	

LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST, W- WATER SAMPLE,
▽-WATER LEVEL, P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02	No. of Undisturbed sample:-00	No. of Vane Shear Test :- NIL
No. of Large diameter sample :- NIL	No. of CORE :- 25	No. of Water Sample :-NIL
	No. of S.P.T. :- 04	

SWAYIN & ASSOCIATES
77,SATYANAGAR, BHUBANESWAR
Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT :- "1 X 800 MW KOTHEGUDEM FGD STAGE-VII, UNIT # 12".

TYPE OF BORING-	ROTARY CALYX DRILLING
DIA OF HOLE -	150MM/NX
DEPTH -	30.00 M
COMMENCED ON :-30.08.2021	COMPLETED ON :-01.09.2021
WATER TABLE:- 1.10 M	

CLIENT :- BHARAT HEAVY ELECTRICALS LIMITED

JOB NO :- SA-1053 | BORE HOLE NO:-IBH-04 | SHEET NO:-02

LOCATION :- KTPS, PALONCHA | PLANT CO-ORDINATES: E:-260.00 N:-1214.00 | RL:-96.898M

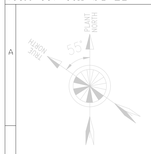
DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REFNO.	CORE RECOVERY%	RQD%	G.W.L OBSER
MODERATELY TO SLIGHTLY WEATHERED, GREYISH, MEDIUM GRAINED MODERATELY FRACTURED ROCK	VERY DENSE	15.00	15.00		15.00			CS	10	27	NIL	
			16.00		16.00			CS	11	29	10	
			17.00		17.00			CS	12	30	NIL	
			18.00		18.00			CS	13	36	12	
			19.00		19.00			CS	14	39	11	
			20.00		20.00			CS	15	41	15	
			21.00		21.00			CS	16	43	NIL	
			22.00		22.00			CS	17	40	NIL	
			23.00		23.00			CS	18	44	12	
			24.00		24.00			CS	19	47	25	
			25.00		25.00			CS	20	49	15	
			26.00		26.00			CS	21	51	21	
			27.00		27.00			CS	22	53	14	
			28.00		28.00			CS	23	55	NIL	
			29.00		29.00			CS	24	50	NIL	
BH TERMINATED AT THE DEPTH OF 30.00M		30.00	30.00		30.00			CS	25	57	NIL	

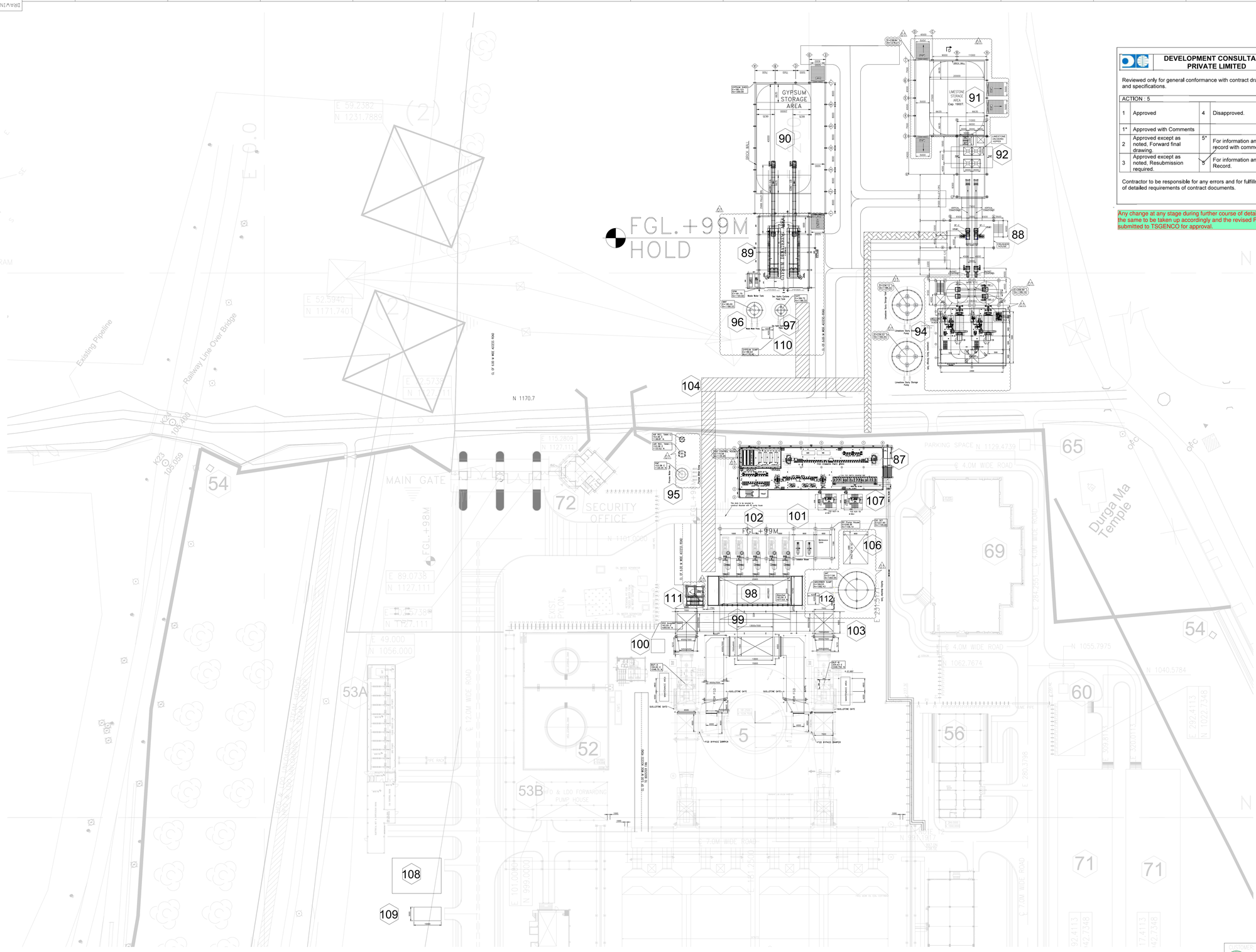
LEGEND:-

UDS-UNDISTURBED SAMPLE, DS- DISTURBED SAMPLE, SPT-STANDARD PENETRATION TEST W- WATER SAMPLE,
▽-WATER LEVEL P-PENETROMETRE TEST, V- VANE SHEAR TEST, C-CORE RECOVERY

No. of disturbed sample :- 02 No. of Large diameter sample :- NIL	No. of Undisturbed sample:-00 No. of CORE :- 25 No. of S.P.T. :- 04	No. of Vane Shear Test :- NIL No. of Water Sample :-NIL

COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company.





DEVELOPMENT CONSULTANTS PRIVATE LIMITED

Reviewed only for general conformance with contract drawings and specifications.

ACTION : 5			
1	Approved	4	Disapproved.
1*	Approved with Comments		
2	Approved except as noted, Forward final drawing.	5*	For information and record with comments.
3	Approved except as noted, Resubmission required.	5	For information and Record.

Contractor to be responsible for any errors and for fulfillment of detailed requirements of contract documents.

Any change at any stage during further course of detail engineering, the same to be taken up accordingly and the revised Plot Plan to be submitted to TSGENCO for approval.

IDENTIFICATION NUMBER	DESCRIPTION
87	FGD CONTROL ROOM
88	LIME STONE GRINDING BUILDING
89	GYPSUM DEWATERING BUILDING
90	GYPSUM STORAGE
91	UNCRUSHED LIMESTONE STORAGE
92	LIMESTONE UNLOADING HOPPER
93	VOID
94	LIMESTONE SLURRY STORAGE TANK
95	PROCESS WATER TANK
96	WASTE WATER TANK
97	SECONDARY HYDROCYCLONE FEED TANK
98	ABSORBER
99	GGH
100	BOOSTER FAN
101	OXIDATION BLOWER
102	RC PUMP
103	AUX ABSORBENT TANK
104	PIPE RACK
105	VOID
106	SPACE FOR DG SET FOR FGD
107	TRANSFORMER FOR FGD
108	ACW/DMCW P/H FOR FGD
109	FRP COOLING TOWER FOR FGD
110	GYPSUM SUMP
111	EMERGENCY QUENCH TANK
112	ABSORBER SUMP

LEGEND:-

FGL - FINISHED GROUND LEVEL
FFL - FINISHED FLOOR LEVEL

- PIPE&CABLE RACK
- CABLE RACK

NOTES:-

1. ALL DIMENSIONS AND CO-ORDINATES ARE IN METER UNLESS NOTED OTHERWISE.
2. THE FINISHED FLOOR LEVEL (FFL) OF POWER HOUSE BUILDING GROUND FLOOR IS EL. 0.00M WHICH CORRESPONDS TO 0.5M (RL. 99.5M) ABOVE FGL.
3. THE EXISTING BUILDINGS SHOWN IN SHADED LINE IN THE POWER PLANT AREA, ETC. AND AS REQUIRED FOR THE CONSTRUCTION OF THE FACILITIES FOR UNIT #12 ARE TO BE DISMANTLED.
4. THE PIPE RACK SHOWN IS INDICATIVE ONLY.
5. 400KV OUTGOING LINES ARE TO BE ALIGNED DULY CLEARING THE RE-ROUTED 220KV LINES RUNNING ALONG THE PLANT BOUNDARY.
6. RE-ROUTING OF EXISTING 400KV LINE NEAR PROPOSED SWITCHYARD AND CHP AREA TO BE SUITABLY INCORPORATED IN THIS DRAWING BY TSGENCO.
7. CUST. GRIDS HAVE BEEN CONVERTED TO PLANT GRIDS. REFERENCE POINT HAS BEEN INDICATED.
8. DUE TO REVISED MARSHALLING YARD, RAIL TRACKS ARE COMING OVER RAW WATER PIPES. HENCE, CULVERT TO BE PROVIDED AS INDICATED IN THE PLOT PLAN AND NECESSARY APPROVAL FROM RITES/ OTHER AGENCIES TO BE ARRANGED BY TSGNECO.
9. MARSHALLING YARD, RAIL TRACKS ARE CONSIDERED AT FGL 104.0M
10. THE CORDINATES OF APPROACH ROADS NOT SHOWN IN THIS REVISION SHALL BE INDICATED IN FURTHER REVISION OF PLOT PLAN AS PER RESPECTIVE FACILITY REQUIREMENTS.
11. REFER PLOT PLAN DRAWING (PE-DG-410-100-M001)FOR IDENTIFICATION NUMBER 1-86.
12. CONTINUATION OF THE POWER DUCT IS ON THE EXISTING PIPE RACK AND SAME IS TO BE REFFRED IN BHEL DWG NO : PE-DG-439-100-E008 .
13. THE HOLD ON THE REFRENCE LEVELS SHALL BE UPDATED AFTER THE RECEIPT OF SURVEY REPORT

REFERENCE DWG. :-

1.	PLOT PLAN	PE-DG-439-100-M001
2.	CONTROL ROOM LAYOUT PLAN	PE-DG-439-100-E008
3.	YARD PIPING AND TRESTLE LAYOUT FOR FGD PLANT	PE-DG-439-181-M004

REV.	DATE	ALTD	CHD	APPD
04	17.06.2021	RAVI	UDAY KUMAR V	
	NO ALTERATION.			
03	05.06.2021	RAVI	UDAY KUMAR V	
	REVISED AS PER CUSTOMER COMMENTS.			
02	13.05.2021	RAVI	UDAY KUMAR V	
	REVISED AS PER LATEST IMPUTS.			
01	15.04.2021	RAVI	V.U.K	G.S
	Revised as per latest inputs and customer comments			

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
1x800 MW KOTHAGUDAM TPS STAGE-VII UNIT#12, PALONCHA

CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA MUMBAI CHENNAI NEW DELHI

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING & SYSTEM DIVISION

COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company.

DEPT.	NAME	DATE
DSN	RA	-Sd- 13.01.2017
CHD	GSF	-Sd- 13.01.2017
APPD	BKA	-Sd- 13.01.2017
APPD	JJ	-Sd- 13.01.2017

TITLE: FGD PLOT PLAN

DEPT. DRG. 1:500
DRAWING NO. PY-LQ-0-M112-1252-01
SHEET 1 OF 1 REV. 04
SIZE-A0

Annexure

C1

DATE:31/08/2021

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 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	24500.00	24500.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	10940.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	53560.00
4	PORTAL CRANE, 360T	15	14070.00	13390.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	52770.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded [illegible])	15	68610.00	65280.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	31880.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	19920.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	28690.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	30130.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	25110.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	34580.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	14390.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18050.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	15940.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	20720.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10360.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	12750.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10420.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10200.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8440.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9560.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9560.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5210.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	5880.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5150.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4230.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	2910.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2180.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2180.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	680.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	370.00

Annexure

C1

DATE:31/08/2021

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 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	650.00	640.00
31	FORK LIFT 3T	5	540.00	530.00

Annexure C2 DATE:31/08/202

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 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	27230.00	27230.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12160.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	59520.00
4	PORTAL CRANE, 360T	15	15630.00	14880.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	58630.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	72540.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	35420.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	22140.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	31880.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	33480.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	27900.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	38420.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	15990.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20060.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	17710.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	23020.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	11510.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14170.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11580.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11330.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9380.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	10620.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	10620.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5790.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6540.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5720.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4700.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3240.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2430.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2430.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	760.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	410.00

Annexure C2 DATE:31/08/202

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 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

Annexure I

RATES FOR INTER REGIONAL HIRE CHARGES FOR CRANES OF CAPACITY 75 TON OR MORE FOR PERIOD 01-09-2021 TO 31-08-2023

Dt : 31/08/2021

SL NO.	ITEM DESCRIPTION	Rates (Rs./MONTH) valid from 01/09/2021 to 31/8/2023
I.	CRANES : -	
1	Portal Gantry Crane 500T	1243192
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	631183
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	2717358
4	PORTAL CRANE, 360T	679333
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	2676917
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	3311783
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	1617475
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	1010917
9	MANITOWOC M-250T TRUCK CRANE	1455725
10	270 MT Class Crawler Crane- Manitowoc Model 2250	1528508
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	1273758
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	1754150
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	730283
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	915892
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	808733
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	1051358
15	CRAWLER CRANE SUMITOMO, 150T	525675
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	646983
17	CRAWLER CRANE, 120 T Fushun Model QUY120	601125
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	517592
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	428625
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	485242
20	CRAWLER CRANE 100 T (KH 500)	485242
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	300558
22	ROUGH TERRAIN CRANE 75T (RT880)	321758
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	281533

ANNEXURE-T I
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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 FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500

ANNEXURE-T I
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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
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

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 01/09/2021 to 31/8/2023
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
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 DIAGONISTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	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

ANNEXURE-T I
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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
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
96	Plasma Cutting Machine (With complete accessories)	310
97	JCB make DG Set 80 KVA	670
98	Diesel Generating Set 82.5 KVA	610
99	Portable Jacking Oil Pump	1080
100	Alloy Analyser	1770

ANNEXURE-T II
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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	ELCTRIC WINCH 5T	1410
6	ELCTRIC 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 CAPACITY WITHOUT STORAGE TANK	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 OIL)	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	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
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010

ANNEXURE-T II
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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
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

ANNEXURE-T II
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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 DIAGONISTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast - 9 metres (4X400 W)	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	510
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	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 AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500

ANNEXURE-T II
DT: 31/08/2021

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 01/09/2021 to 31/8/2023
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
96	Plasma Cutting Machine (With complete accessories)	340
97	JCB make DG Set 80 KVA	740
98	Diesel Generating Set 82.5 KVA	680
99	Portable Jacking Oil Pump	1200
100	Alloy Analyser	1970



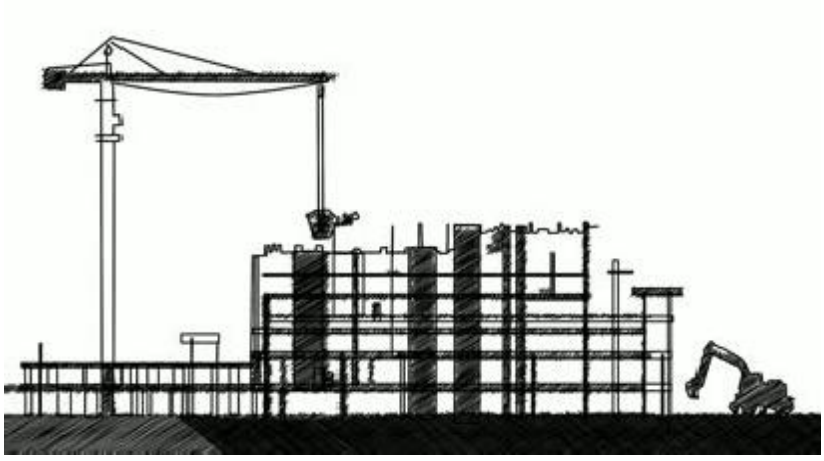
HEALTH, SAFETY and ENVIRONMENT PLAN

for

SITE OPERATIONS

by

SUB-CONTRACTORS



POWER SECTOR

HSE PLAN FOR SITE OPRATIONS 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 INFRASTUCTURE	
• 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.

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/MONREP/02** Dated 08-Jan-2020	Rohit Kumar	Santosh Nair, GM (MSX & HSE)	

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

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

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

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.

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

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:

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.

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:

$$\frac{\text{Number of Reportable LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

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:

$$\frac{\text{Days lost due to LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI}}{\text{Average number of manpower deployed}} \times 1000$$

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

2	Safety-Steward/ 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.

- 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 work site.
- 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

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:

  - Mobile cranes.
  - Side Booms.
  - Forklifts.
  - Grinding machine.
  - Drilling machine.
  - Air compressors.
  - Welding machine.
  - Generator sets.
  - Dump Trucks.
  - Excavators.
  - Dozers
  - Grit Blasting Equipment.
  - 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.

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.

- 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.

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

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:

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 rough measurements etc.	300
7.	Fine work like precision assembly, precision measurements etc.	700
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)

- 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:
    - Details of the job being intended for immediate execution.
    - The relevant hazards and risks involved in executing the job and their control and mitigating measures.
    - Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
    - Recent non-compliances observed.
    - Appreciation of good work done by any person.
    - 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:
    - Hazards identification and risk analysis (HIRA)
    - Work Permit System
    - Incident investigation and reporting
    - Fire fighting
    - First aid
    - Fire-warden training
    - EMS and OHSMS
    - T & Ps fitness and operation

- Electrical safety
- Welding, NDE & Radiological safety
- 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

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

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 ton
  Refer 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.

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 ad 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.

- 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 then ¼ 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 saver, 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.

- 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.

- 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

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.

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

- 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:

- A high level of stability.
- A safe means of access/egress.
- Suitable and effective service and parking brakes.
- Windscreens with wipers and external mirrors giving optimum all round visibility.
- Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- Provision of seat belts.
- Guards on dangerous parts.
- Driver protection - to prevent injury from overturning and from falling objects/materials.
- Driver protection from adverse weather.
- No vehicle shall be parked below HT/LT power lines.
- Valid Pollution Under Control certification for all vehicles

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.
  - Brakes.
  - Tires.
  - Steering.
  - Mirrors.
  - Windscreen waters.
  - Wipers.
  - Warning signals.
  - 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.

- 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.

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
    - Fall arrestor
    - Lifelines
    - Safety nets
    - Fencing and barricading
    - Warning signage
    - Covering of opening
    - Proper scaffolding with access and egress.
    - 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.

- 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.

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.

- 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 Slinging 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.

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:
  - Implementation of earlier MOM
  - HSE performance
  - HSE inspection
  - HSE audit and CAPA
  - HSE training
  - Health check-up camp
  - HSE planning for the erection and commissioning and installation activities in the coming month
  - 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

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

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.

(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.

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	Yes	No	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNELPROTECTIVEEQUIPTMENTS				
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				

Angle + 70^0 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				

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.				

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

(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 20030	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

ANNEXURE 04 : SAFETY FORMATS
&
ANNEXURE 05 : WORK PERMIT FORMATS

	POWER SECTOR	FORMAT NO: HSEP:14-F01 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF FIRST AID BOX	

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.		

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	FORMAT NO: HSEP:14-F02 REV NO.: 00 PAGE NO. 1 OF 02
	HEALTH CHECK UP	

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**	
General Physical Examination			
Height	:		
Weight	:		
BMI	:		
Built And nourishment	:		
Pallor	:		
Temperature	:		
Chest Expansion	:	Inspiration	Expansion
Lymph Node Enlargement	:		
Ear, Nose, Throat	:		
Ear	:		
Nose	:		
Throat	:		

EXAMINATION		OBSERVATION	
Cardiovascular System Examination :			
Inspection	:		
Palpation	:	Pulse	BP
Auscultation (Heart Sounds)	:		
Respiratory System	:		
Inspection	:	Respiratory Rate	
Palpation:	:		
Percussion	:		
Auscultation (Breath Sounds)	:		
Examination of Abdomen	:		
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 **PERSONAL PROTECTIVE EQUIPMENTS**	FORMAT NO: HSEP:14-F06 REV NO.: 00 PAGE NO. 01 OF 01

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 **STATUS OF T&Ps**	FORMAT NO: HSEP:14-F08 REV NO.: 00 PAGE NO. 01 OF 01

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 filly extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		

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?				

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?		

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	Yes	No	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 **INSPECTION OF ELECTRICAL INSTALLATION**	FORMAT NO: HSEP:14-F12 REV NO.: 00 PAGE NO. 01 OF 02

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?		

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 **Inspection of Excavation**	FORMAT NO: **HSEP:14-F13E** REV NO.: 00 PAGE NO. 01 OF 01

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)**

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 Slinging 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.

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.)

_____

Penalty imposed:

1, Rate as per above chart_____

2. No. of Persons/ machine/ event/ labour _____

3. Total Penalty= 1. X 2. =_____

Signature:

Witnessed by: (Sub- Contractor representative) (BHEL Personnel)

Name_____ Name_____

Distribution: 1 Copy: to Sub- contractor,
1 Copy to Site Construction Manager (BHEL)

बी एच ई एल BHEL	**POWER SECTOR- HQ** **Incident Report** (To be submitted within 24 hours of time of incident)	FORMAT NO: HSEP:14-F15 REV NO.: 00 PAGE NO. 01 OF 01

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 NO: **HSEP:14-F30**
	Format for Monthly HSE Planning & Review	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: F01	Areas 1. … …	
2	Health check-up as per Format: F02	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: F03	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: F04	Locations of TBTs & No. of workers **1.** …	
5	PPE usage and issue as per Format: F06		
6	Inspection of T&Ps as per Format: F07	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: F08		
8	Inspection of Cranes & Winches as per Format: F09	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. …**	

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 …**	

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**	
Agency Name: Sign: Date:	**BHEL** Name: Sign: Date:	**Agency** Name: Sign: Date:	**BHEL** Name: Sign: Date:

	POWER SECTOR	FORMAT NO: **HSEP:14-F31** A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

Note: Following format to be submitted (preferably) in excel/ soft copy by subcontractor daily at the end of each shift. Any photographs/ records to be attached

Site									**Subcontractor**																		
Year							**Month**													**Day**							
SHIFT	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	T&P Inspection (Names & Nos. Inspected)	Safety Walk (Designation, Areas)	HSE Meeting	Safety Reward (Details)	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
Day																											
Night															NA		NA	NA	NA								

	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)						

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

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

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 an 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**


बी एच ई एल
BHEL

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **1** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: PLAN/ REVIEW OF WORK FOR THE MONTH OF …….. Date of Plan/ Review……

SN.	Description of Work	Unit of Measur-ement	Unit Rate	Planned (QTY Planned for the month as per Part –C of last month)		Cumulative Shortfall attributable to contractor upto last month (Refer Note 1)		Achieved		Shortfall attributable to BHEL w.r.t Plan (as per Col. 3 of Part-D)		Cumulative Shortfall attributable to Contractor upto & including this month		REMARKS (Reasons for Shortfall attributable to Contractor. Supporting documents to be kept as record.)
(a)	(b)	(c)	(d)	A		B		C		D		E=A+B-C-D		
				Phy.	Financial	Phy	Financial	Phy.	Financial	Phy.	Financial	Phy.	Financial	
	Value of Other Items not mentioned above but planned to be executed in this month													
Total					ΣA		ΣB		ΣC		ΣD		ΣE	

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: Contd…….

Note 1: **In addition to the work planned as per Col. 'A', Contractor shall also make full efforts to minimize the 'Cumulative shortfall attributable to contractor upto the month' as mentioned in Col. 'B' by enhancing its resources, so as to achieve the completion of activities as per agreed schedule. In case contractor is not able to execute the entire shortfall, then BHEL 'Engineer in-charge', shall decide the priority of work to be executed and it shall be binding on the contractor.**

Note 2: Percentage Shortfall attributable to contractor w.r.t. **"**Plan - Shortfall attributable to BHEL**"** for the month = [(ΣE-ΣB)/(ΣA-ΣD)]x100
In case, (ΣE-ΣB) is negative, then it shall be treated as zero percent."

Note 3: Form 14 should include all items being planned in the current month, and all items against which shortfall was attributable to contractor till previous month. However, for practical reason, if it is not possible to mention some of the items in Form-14 being planned to be executed in this month, then also value of such items shall necessarily be included in calculation of Total Value.

Note 4: In case reason for shortfall attributable to contractor is w.r.t. T&P and Manpower, it should be in conformity with Part B1 and B2.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-1: PLAN/REVIEW OF DEPLOYMENT OF MAJOR T&Ps FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	PLAN				DEPLOYMENT STATUS			
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Weightage assigned to planned T&P (in fraction such that ΣC =1)	Actual Deployed Quantity	Actual Deployment Period (in days)	Weighted T&P Deployed	REMARKS (Works affected due to non-deployment of T&Ps)
		A	B	C	D	E	F=(C x D x E) / (A x B)	

Note: In case, E>B, it shall be considered as E=B. Similarly, in case D>A, it shall be considered as D=A.
Percentage of T&P Deployed = ΣF x 100

BHEL SCOPE: -

SN.	PLAN			DEPLOYMENT STATUS		
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Actual Deployed Quantity	Actual Deployment Period (in days)	REMARKS (Works affected due to non-deployment of T&Ps)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-2: PLAN/ REVIEW OF DEPLOYMENT OF MANPOWER FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	Area of Work	Category of Labour	No. of Labour required as per category	Deployment Period (in days)	No. of Labour actually deployed	Actual Deployment Period (in days)	REMARKS (Works affected due to non-availability of labour)
			A	B	C	D	

Percentage of Manpower Deployed=100 x Σ(CxD)/Σ(AxB)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **5** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – C: PLAN(PHYSICAL) FOR THE NEXT MONTH i.e. ……..…….. Date of Plan ……

SN.	Description of work	Original Planned Quantity	Planned Quantity (excluding shortfalls attributable to contractor till date)	Unit of Measu-rement	T&Ps Required				Manpower Required		REMARKS (Reasons for difference in Original Planned Quantity w.r.t. Planned quantity to be given)
					Contractor Scope		BHEL Scope		Category of Labour	No. of Labour required as per Category	
					Major T&P to be deployed as per work planned for the month	Quantity	Major T&P to be deployed as per work planned for the month	Quantity			

Note 1: Planned quantity should be based on available/ expected fronts/ inputs in the next month

Note 2: "Original Planned Quantity" shall be as per latest jointly agreed programme between BHEL and Contractor before commencement of work or at the time of latest Time Extension, as the case may be.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – D: REASONS FOR SHORTFALL ATTRIBUTABLE TO BHEL IN RESPECT OF PLAN FOR THE MONTH……

SN.	Description of Work (from Part-A)	Quantities Affected		Reasons for Shortfall attributable to BHEL	Agency responsible for reasons for Shortfall	Remarks (Supporting Documents in respect of agency responsible)
		(Physical Quantity)	Unit of Measu-rement			
1	2	3	4	5	6	7

Note1: Reasons for shortfall shall include non-availability of fronts/ drawings/ materials/ T&P (BHEL Scope)/ clearances etc. and other hindrances for which contractor is not responsible.

Note2: Agency responsible may be BHEL Site/ MUs/ Design Centre/ BHEL Customer/ other Contractors etc.

BHEL
(Sign with name, designation and date)

Project		**Vendor**			**Package/ Unit**	
Sl. No.	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents**
#1.01	Cumulative number of days in the month, the nominated Quality Officer or his authorised nominee was not available	QUALITY	1.5		Quality Officer or his authorised nominee should be available for all the days of working at site	Daily Log Book entry/Incident Registers/letter references
#1.02	Number of instances of non- compliance wrt FQP, Standard Drawings, Specifications, E&C Manuals etc.	QUALITY	1.5		No deviation from FQP, Standard Drawings, Specifications, E&C Manuals etc. is allowed without BHEL Engineer's approval.	Daily Log Book entry/Incident Registers/letter references
#1.03	Percentage submission of test certificates for batches of welding electrodes, cement, sand, aggregate, consumable, Paints etc. as applicable for this month OR In case of MM & MH package, monthly checks for Storage/Preservation of material.	QUALITY	1		Submission of 100% Test certificates for materials as per FQP is mandatory. MM & MH package: Storage/Preservation as per manual/procedure.	Daily Log Book entry/Incident Registers/letter references
#1.04	Number of incidences of improper storage & preservation (not in accordance to the guidelines of BHEL MUs or approved FQP) of materials, consumables (viz. gases, welding electrodes & fluxes, fuel etc.) & bought-out items (paints, fasteners etc.) under the custody of the contractor	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#1.05	Rework/ Rejection instances in a month necessitated due to deviation from Standard Drawings /Specifications /Manuals /E&C procedures /FQPs or due to Poor Workmanship by contractor	QUALITY	2		Reworks/ Rejection should be as minimum as possible. Total number of reworks/ rejections due to reasons attributable to contractor.	Daily Log Book entry/Incident Registers/letter references
#1.06	Delay in preparation & submission of signed protocols / log sheets / site register / NDT test reports as per approved FQP/ Qualified Welder List along with photocopies of Welder ID cards / Welder Performance Evaluation records etc. in the month OR in case of MM / MH package reconciliation statement / verification report.	QUALITY	1		Within 2 days of measurements taken or within first 3 working days of next month, as advised by BHEL Engineer	Daily Log Book entry/Incident Registers/letter references
#1.07	Number of instances for Major equipment/product failure due to negligence/improper work/poor workmanship by contractor	QUALITY	1		No such event should happen	Daily Log Book entry/Incident Registers/letter references
#1.08	Total number of complaints received in the month on the quality of finish / aesthetics	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/ Unit**	
Sl. No.	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents**
#2.01	Cumulative number of days of delay in submission of Plan FOR THE MONTH supported by deployment plan of Major T&Ps and Manpower (as per Form F-14) and relevant construction/layout drawings - like A4 plan / elevation views of plan status for structures / pressure parts/Civil Works, Piping isometrics for piping, Layout / PID / System reference sketch, Unloading / storage plans etc.as applicable.	PERFORMANCE	5		Number of days delayed from second working day of the month	Daily Log Book entry/Incident Registers/letter references
#2.02	Percentage of timely submission of Daily Reports for Progress of work, Resources, Consumables etc.	PERFORMANCE	1.5		Percentage of timely submission of daily reports/ Scheduled date is successive next day for each day	Daily Log Book entry/Incident Registers/letter references
#2.03	Number of days delayed for submission of FQP log sheets / protocols / Monthly Progress Reports for the work executed during the month under measurement	PERFORMANCE	1.5		Number of days delayed/Scheduled date is first 2 working days of next month	Daily Log Book entry/Incident Registers/letter references
#2.04	Percentage Shortfall attributable to contractor w.r.t. “Plan - Shortfall attributable to BHEL” for the month as per Form-14	PERFORMANCE	35		As per Part-A of Form-14	Progress review formats
#2.05	Number of days delayed in submission of Running bills with complete supporting documents (including updated reconciliation statement of BHEL issued material) for the month	PERFORMANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#2.06	Number of times the Top Management of contractor did not respond to critical issues of site, for the month	PERFORMANCE	1		Total number of instances	Daily Log Book entry/Incident Registers/letter references
#2.07	Cumulative number of days in the month the works were stopped / refused on interpretation of contract clauses/scope due to tendency of taking undue advantage by interpreting contract clauses in their favour	PERFORMANCE	2		Cumulative number of days lost	Daily Log Book entry/Incident Registers/letter references
#2.08	Number of times rework was refused by contractor	PERFORMANCE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/ Unit**	
Sl. No.	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents**
#2.09	Cumulative number of days in the month recording / logging was not done in daily log / history register / hindrance register / soft form in a PC maintained at BHEL Site Office	PERFORMANCE	1		Cumulative number of days recording or logging was not done / all days of the month	Daily Log Book entry/Incident Registers/letter references
#3.01	Percentage of Manpower Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B2 of Form-14	Daily Log Book entry/Incident Registers/letter references
#3.02	Percentage of T&P Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B1 of Form-14	Daily Log Book entry/Incident Registers/letter references
#3.03	Cumulative number of major instances in the month hampering / affecting progress of work due to breakdown or non-availability of major T&P and MME for the work, under the scope of Contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#3.04	Cumulative number of major instances in the month hampering / affecting progress of work due to non-availability of Consumables/ use of improper consumables under the scope of contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#4.01	Number of non-compliances during the month for Statutory requirements like validity of Labour Licence, Insurance Policy, Labour Insurance, PF, BOCW Compliance etc. and any other applicable laws/ Regulation, Electrical Licence, T&P fitness certificate, Contractors' All Risk Policy etc. as applicable	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#4.02	Cumulative number of days in a month poor illumination is reported at storage area, erection area, pre-assembly area and other designated areas by BHEL site.	SITE INFRASTRUCTURE & SERVICE	0.5		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.03	Cumulative number of days of non-availability of well-maintained toilets facilities for workers (separate for men and women) and non-availability of potable drinking water stations for workers in specified areas.	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/ Unit**	
Sl. No.	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents**
#4.04	Total number of instances in the month, Housekeeping NOT attended to in spite of instructions by BHEL -i.e. removal / disposal of surplus earth / debris / scrap / unused / surplus cable drums / other electrical items / surplus steel items / packing materials, thrown out scrap like weld butts, cotton waste etc. from the working area to identified locations	SITE INFRASTRUCTURE & SERVICE	2		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.05	Total number of instances in a month, Site Office with reasonably good facilities including enough nos. of computers and printers etc. for use by office and supporting staff was not made available/maintained.	SITE INFRASTRUCTURE & SERVICE	0.5		No discrepancy during regular or surprise visits	Photograph and report of the Engineer
#5.01	Number of days delayed in making labour payments for the last month	SITE FINANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#5.02	Number of complaints from labour/ sub supplier/ sub-contractor for non-receipt of payments from contractor	SITE FINANCE	1.5		Total number of complaints or reporting	Daily Log Book entry/Incident Registers/letter references
#5.03	Number of times the site operations were hampered for want of funds at the disposal of site-in-charge.	SITE FINANCE	1.5		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#6.0	Performance against HSE Parameters (as per Annexure-AA)	HSE	10		Score as per Safety Performance Evaluation System, scaled down to 10	Safety Performance Evaluation System
		Total	**100**			

Less Deduction in Score Due to Fatal Accidents attributable to the Contractor @ 20 points/ accident	
Less Deduction in Score Due to Major Accidents (Permanent Disability or bodily injury by which person injured is prevented to resume to work within 48 hours or more after accident,, Major Damage to Equipment etc.) attributable to the contractor @ 15 points/ accident	
Less Deduction in Score Due to Minor Accidents attributable to the contractor @ 2 points/ accident	
Less Deduction in Score Due to not Maintaining of Labour Colony (if applicable) as per BHEL HSE policy @3 points in a month on verification any day	
Final Score	

Project		**Vendor**			**Package/ Unit**	
Sl. No.	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents**

Performance Score Summary for the Month	**Total Score**	**Score Obtained**
QUALITY	10	
PERFORMANCE	50	
RESOURCES	20	
SITE INFRASTRUCTURE & SERVICE	5	
SITE FINANCE	5	
HSE	10	
OTHERS (deductions if any)	0	-
TOTAL	**100**	

Note:

1) It is only indicative and shall be as per the online format issued by BHEL time to time.
2) No request will be entertained after specified date of current month w.r.t. changes requested in the scores of immediate previous month.

Annexure-AA to Form F-15

Monthly Safety Performance Evaluation of Contractor

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, colour 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
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

7a	Whether Scaffolding pipes made with steel or aluminium, 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 centre, 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. Score obtained in selected parameters divided by maximum possible score of selected parameters shall be multiplied by 10 for use in as per point Sl. no. # 6.0 as detailed at page 4 of Form F-15.

There shall be deduction of marks from overall score for Fatal/ Major/ Minor Accidents and for not maintaining labour colony, as detailed at page 4 of Form F-15.

Form WAM 23

PROFORMA OF BANK GUARANTEE (in lieu of EARNEST MONEY)
(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

Dear Sirs,

In accordance with the terms and conditions of Invitation for Bids/Notice Inviting Tender No……[1] (Tender Conditions), M/s. ……[2] having its registered office at ……[3] (hereinafter referred to as the 'Tenderer'), is submitting its bid for the work of……..[4] invited by Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, 690, Anna Salai, Nandanam, Chennai 600035*

The Tender Conditions provide that the Tenderer shall pay a sum of Rs ……..[5] as Earnest Money Deposit in the form therein mentioned. The form of payment of Earnest Money Deposit includes Bank Guarantee executed by a Scheduled Bank.

In lieu of the stipulations contained in the aforesaid Tender Conditions that an irrevocable and unconditional Bank Guarantee against Earnest Money Deposit for an amount of .....[6] is required to be submitted by the Tenderer as a condition precedent for participation in the said Tender and the Tenderer having approached us for giving the said Guarantee,

we, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank) being the Guarantor under this Guarantee, hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer without any demur, merely on your first demand any sum or sums of Rs.....[6] (in words Rupees.....) without any reservation, protest, and recourse and without the beneficiary needing to prove or demonstrate reasons for its such demand.

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.[6]

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Tenderer in any suit or proceeding pending before any Court or Tribunal, Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment hereunder and the Tenderer shall have no claim against us for making such payment.

We ……. Bank further agree that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Tender or to extend the time of submission of from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said

Tenderer and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Tenderer or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Tenderer or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Tenderer and notwithstanding any security or other guarantee that the Employer may have in relation to the Tenderer's liabilities.

This Guarantee shall be irrevocable and shall remain in force upto and including…….[7] and shall be extended from time to time for such period as may be desired by the Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms hereof. However, unless a demand or claim under this Guarantee is made on us in writing on or before the ……[8] we shall be discharged from all liabilities under this Guarantee.

We, …… Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[6]
b) This Guarantee shall be valid up to …….[7]
c) Unless the Bank is served a written claim or demand on or before _____[8] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

(Signature of Authorised signatory)

Date…….
Place of Issue…….

[1] Details of the Invitation to Bid/Notice Inviting Tender (Tender Ref. No. Eg. - BHEL PSSR SCT XXXX)
[2] Name of Tenderer
[3] REGISTERED Office Address of the Tenderer
[4] Details of the Work i.e Tender Description
[5] EMD Amount as mentioned in Notice Inviting Tender
[6] BG Amount in words and Figures (BG Amount shall be Minimum of EMD amount less Rs. 2 Lakhs)
[7] Validity Date
[8] Date of Expiry of Claim Period (Claim Period shall be minimum of 3 Months after the validity date of Bank Guarantee)

Note:
1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.
2. In Case of Bank Guarantees submitted by Foreign Vendors-

a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.

b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)

   b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.

   b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.

   b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

PROFORMA OF BANK GUARANTEE (in lieu of SECURITY DEPOSIT)
(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

In consideration of Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, 690, Anna Salai, Nandanam, Chennai 600035* having agreed to exempt _____[1] (Name of the Vendor / Contractor / Supplier) with its registered office at_____[2] (hereinafter called the said "Contractor" which term includes supplier), from demand under the terms and conditions of the Contract arising vide Letter of Intent (LOI) reference No._____ dated _____ [3] valued at Rs. _____ [4] (Rupees _____ only)[4] (hereinafter called the said Contract), of Security Deposit for the due fulfilment by the said Contractor of the terms and conditions contained in the said Contract, on production of a Bank Guarantee for Rs. _____ [5] (Rupees _____ only),

We, the ……(Name & address of the Bank) …… having our Head Office at ……..(hereinafter referred to as the Bank), at the request of _____ [Contractor(s)], being the Guarantor under this Guarantee, do hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer, an amount not exceeding Rs._____ without any demur, immediately on demand from the Employer and without any reservation, protest, and recourse and without the Employer needing to prove or demonstrate reasons for its such demand

Any such demand made on the bank, shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____ [5].

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Contractor(s) in any suit or proceeding pending before any Court or Tribunal or Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this guarantee shall be a valid discharge of our liability for payment hereunder and the Contractor(s) shall have no claim against us for making such payment.

We, further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied & the Employer certifies that the terms and conditions of the said Contract have been fully and properly carried out by the said contractor(s) or acceptance of the final bill or discharge of this guarantee by the Employer, whichever is earlier. This guarantee shall initially remain in force upto and including _____[6] and shall be extended from time to time for such period as may

be desired by the Employer. Unless a demand or claim under this guarantee is made on us in writing on or before the _____[7], we shall be discharged from all the liability under this guarantee thereafter.

We, _____(indicate the name of the Bank) further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said contractor(s) and to forbear or enforce any of the terms and conditions relating to the said Contract and we shall not be relieved from our liability by any reason of any such variation or extension being granted to the said contractor(s) or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor's liabilities.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Contractor but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof. This guarantee will not be discharged due to the change in the constitution of the Bank or the Contractor(s).

We, ……. BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[5]

b) This Guarantee shall be valid up to ……[6]

c) Unless the Bank is served a written claim or demand on or before _____[7] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

Date _____ Day of _____

for_____ (indicate the name of the Bank)

(Signature of Authorised signatory)

[1] NAME OF VENDOR /CONTRACTOR / SUPPLIER
[2] REGISTERED OFFICE ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.
[3] LETTER OF INTENT(LOI) REFERENCE NO. WITH DATE
[4] CONTRACT VALUE (AS MENTIONED IN LOI)
[5] BG AMOUNT IN FIGURES AND WORDS
[6] VALIDITY DATE
[7] DATE OF EXPIRY OF CLAIM PERIOD (CLAIM PERIOD SHALL BE MINIMUM OF 3 MONTHS AFTER VALIDITY DATE)

Note:

1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.
2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.

      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

Procedure-2.3

PROCEDURE FOR CONDUCT OF CONCILIATION PROCEEDINGS

1. The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided herein:

2. The party desirous of resorting to Conciliation shall send an invitation/notice in writing to the other party to conciliate specifying all points of Disputes with details of the amount claimed. The party concerned shall not raise any new issue thereafter. Parties shall also not claim any interest on claims/counter-claims from the date of notice invoking Conciliation till the conclusion of the Conciliation proceedings. If BHEL is to initiate Conciliation, then, the invitation to Conciliate shall be extended to the concerned Stakeholder in **Format 7** hereto. Where the stakeholder is to initiate the Conciliation, the notice for initiation of Conciliation shall be sent in **Format-8** hereto.

3. The party receiving the invitation/notice for Conciliation shall within 30 days of receipt of the notice of Conciliation intimate its consent for Conciliation along with its counter-claims, if any.

4. The Conciliation in a matter involving claim or counter-claim (whichever is higher) up to Rs 5 crores shall be carried out by sole Conciliator nominated by BHEL while in a matter involving claim or counter-claim (whichever is higher) of more than Rs 5 crores Conciliation shall be carried out by 3 Conciliators nominated by BHEL. The appointment of Conciliator(s) shall be completed and communicated by the concerned Department/Group of BHEL Unit/Division/Region/Business Group to the other party and the Conciliator(s) within 30 days from the date of acceptance of the invitation to conciliate by the concerned party in the **Format-9**. The details of the Claim, and counter-claim, if any, shall be intimated to the Conciliator(s) simultaneously in **Format-5**.

5. The Parties shall be represented by only their duly authorized in-house executives/officers and neither Party shall be represented by a Lawyer.

6. The first meeting of the IEC shall be convened by the IEC by sending appropriate communication/notice to both the parties as soon as possible but not later than 30 days from the date of his/their appointment. The hearings in the Conciliation proceeding shall ordinarily be concluded within two (2) months and, in exceptional cases where parties have expressed willingness to settle the matter or there exists possibility of settlement in the matter, the proceedings may be extended by the IEC by a maximum of further 2 months with the consent of the Parties subject to cogent reasons being recorded in writing.

7. The IEC shall thereafter formulate recommendations for settlement of the Disputes supported by reasons at the earliest but in any case within 15 days from the date of conclusion of the last hearing. The recommendations so formulated along with the reasons shall be furnished by the IEC to both the Parties at the earliest but in any case within 1 month from the date of conclusion of the last hearing.

8. Response/modifications/suggestions of the Parties on the recommendations of the IEC are to be submitted to the IEC within time limit stipulated by the IEC but not more than 15 days from the date of receipt of the recommendations from the IEC.

9. In the event, upon consideration, further review of the recommendations is considered necessary, whether by BHEL or by the other Party, then, the matter can be remitted back to the IEC with request to reconsider the same in light of the issues projected by either/both the Parties and to submit its recommendations thereon within the following 15 days from the date of remitting of the case by either of the Parties.

10. Upon the recommendations by the Parties, with or without modifications, as considered necessary, the IEC shall be called upon to draw up the Draft Settlement Agreement in terms of the recommendations.

11. When a consensus can be arrived at between the parties only in regard to any one or some of the issues referred for Conciliation the draft Settlement Agreement shall be accordingly formulated in regard to the said Issue(s), and the said Settlement Agreement, if signed, by the parties, shall be valid only for the said issues. As regards the balance issues not settled, the parties may seek to resolve them further as per terms and conditions provided in the contract.

12. In case no settlement can be reached between the parties, the IEC shall by a written declaration, pronounce that the Conciliation between the parties has failed and is accordingly terminated.

13. Unless the Conciliation proceedings are terminated in terms of para 22 (b), (c) & (d) herein below, the IEC shall forward his/its recommendations as to possible terms of settlement within one (1) month from the date of last hearing. The date of first hearing of Conciliation shall be the starting date for calculating the period of 2 months.

14. In case of 3 members IEC, 2 members of IEC present will constitute a valid quorum for IEC and meeting can take place to proceed in the matter after

seeking consent from the member who is not available. If necessary, videoconferencing may be arranged for facilitating participation of the members. However, the IEC recommendations will be signed by all members. Where there is more than one (1) Conciliator, as a general rule they shall act jointly. In the event of differences between the Members of IEC, the decision/recommendations of the majority of the Members of IEC shall prevail and be construed as the recommendation of the IEC.

15. The Draft Settlement Agreement prepared by the IEC in terms of the consensus arrived at during the Conciliation proceedings between the Parties shall be given by the IEC to both the parties for putting up for approval of their respective Competent Authority.

16. Before submitting the draft settlement agreement to BHEL's Competent Authority viz. the Board Level Committee on Alternative Dispute Resolution (BLCADR) for approval, concurrence of the other party's Competent Authority to the draft settlement agreement shall be obtained by the other party and informed to BHEL within 15 days of receipt of the final draft settlement agreement by it. Upon approval by the Competent Authority, the Settlement Agreement would thereafter be signed by the authorized representatives of both the Parties and authenticated by the members of the IEC.

17. In case the Draft Settlement Agreement is rejected by the Competent Authority of BHEL or the other Party, the Conciliation proceedings would stand terminated.

18. A Settlement Agreement shall contain a statement to the effect that each of the person(s) signing thereto (i) is fully authorized by the respective Party(ies) he/she represents, (ii) has fully understood the contents of the same and (iii) is signing on the same out of complete freewill and consent, without any pressure, undue influence.

19. The Settlement Agreement shall thereafter have the same legal status and effect as an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal passed under section 30 of the Arbitration and Conciliation Act, 1996.

20. Acceptance of the Draft Settlement Agreement/recommendations of the Conciliator and/or signing of the Settlement Agreement by BHEL shall however, be subject to withdrawal/closure of any arbitral and/or judicial proceedings initiated by the concerned Party in regard to such settled issues.

21. Unless otherwise provided for in the agreement, contract or the Memorandum of Understanding, as the case may be, in the event of likelihood of prolonged

absence of the Conciliator or any member of IEC, for any reason/incapacity, the Competent Authority/Head of Unit/Division/Region/Business Group of BHEL may substitute the Conciliator or such member at any stage of the proceedings. Upon appointment of the substitute Conciliator(s), such reconstituted IEC may, with the consent of the Parties, proceed with further Conciliation into the matter either de-novo or from the stage already reached by the previous IEC before the substitution.

22. The proceedings of Conciliation under this Scheme may be terminated as follows:

a. On the date of signing of the Settlement agreement by the Parties; or,

b. By a written declaration of the IEC, after consultation with the parties, to the effect that further efforts at conciliation are no longer justified, on the date of the declaration; or,

c. By a written declaration of the Parties addressed to the IEC to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

d. By a written declaration of a Party to the other Party and the IEC, if appointed, to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

e. On rejection of the Draft Settlement Agreement by the Competent Authority of BHEL or the other Party.

23. The Conciliator(s) shall be entitled to following fees and facilities:

Sl No	**Particulars**	**Amount**
1	Sitting fees	Each Member shall be paid a Lump Sum fee of Rs 75,000/- for the whole case payable in terms of paragraph No. 27 herein below.
2	Towards drafting of settlement agreement	In cases involving claim and/or counter-claim of up to Rs 5crores. Rs 50,000/- (Sole Conciliator) In cases involving claim and/or counter-claim of exceeding Rs 5 crores but less than Rs 10 crores. Rs 75,000 (per Conciliator)

Sl No	Particulars	Amount
		In cases involving claim and/or counter-claim of more than Rs 10 crores. Rs 1,00,000/- (per Conciliator) Note: The aforesaid fees for the drafting of the Settlement Agreement shall be paid on the, Signing of the Settlement Agreement after approval of the Competent Authority or Rejection of the proposed Settlement Agreement by the Competent Authority of BHEL.
3	Secretarial expenses	Rs 10,000/- (one time) for the whole case for Conciliation by a Sole Member IEC. Where Conciliation is by multi member Conciliators –Rs 30,000/- (one time)- to be paid to the IEC
4	Travel and transportation and stay at outstation Retired Senior Officials of other Public Sector Undertakings (pay scale wise equivalent to or more than E-8 level of BHEL)	As per entitlement of the equivalent officer (pay scale wise) in BHEL.
	Others	As per the extant entitlement of whole time Functional Directors in BHEL. Ordinarily, the IEC Member(s) would be entitled to travel by air Economy Class.
5	Venue for meeting	Unless otherwise agreed in the agreement, contract or the Memorandum of Understanding, as the case may be, the venue/seat of proceedings shall be the location of the concerned Unit / Division / Region /

Sl No	Particulars	Amount
		Business Group of BHEL. Without prejudice to the seat/venue of the Conciliation being at the location of concerned BHEL Unit / Division / Region / Business Group, the IEC after consulting the Parties may decide to hold the proceedings at any other place/venue to facilitate the proceedings. Unless, Parties agree to conduct Conciliation at BHEL premises, the venue is to be arranged by either Party alternately.

24. The parties will bear their own costs including cost of presenting their cases/evidence/witness(es)/expert(s) on their behalf. The parties agree to rely upon documentary evidence in support of their claims and not to bring any oral evidence in IEC proceedings.

25. If any witness(es) or expert(s) is/are, with the consent of the parties, called upon to appear at the instance of the IEC in connection with the matter, then, the costs towards such witness(es)/expert(s) shall be determined by the IEC with the consent of the Parties and the cost so determined shall be borne equally by the Parties.

26. The other expenditures/costs in connection with the Conciliation proceedings as well as the IEC's fees and expenses shall be shared by the Parties equally.

27. Out of the lump sum fees of Rs 75,000/- for Sitting Fees, 50% shall be payable after the first meeting of the IEC and the remaining 50% of the Sitting Fees shall be payable only after termination of the conciliation proceedings in terms of para 22 hereinabove.

28. The travelling, transportation and stay at outstation shall be arranged by concerned Unit as per entitlements as per Serial No. 4 of the Table at para 23 above, and in case such arrangements are not made by the BHEL Unit, the same shall be reimbursed to the IEC on actuals limited to their entitlement as per Serial No. 4 of the Table at Para 23 above against supporting documents. The IEC Member(s) shall submit necessary invoice for claiming the fees/reimbursements.

29. The Parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement,

except where its disclosure is necessary for purposes of its implementation and enforcement or as required by or under a law or as per directions of a Court/Governmental authority/ regulatory body, as the case may be.

30. The Parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the Disputes that is the subject of the Conciliation proceedings:

a. Views expressed or suggestions made by the other party in respect of a possible settlement of the Disputes;

b. admissions made by the other party in the course of the Conciliator proceedings;

c. proposals made by the Conciliator;

d. The fact that the other Party had indicated his willingness to accept a proposal for settlement made by the Conciliator.

31. The Parties shall not present the Conciliator(s) as witness in any Alternative Dispute Resolution or Judicial proceedings in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

32. None of the Conciliators shall act as an arbitrator or as a representative or counsel of a Party in any arbitral or judicial proceeding in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

33. The Parties shall not initiate, during the Conciliation proceedings, any arbitral or judicial proceedings in respect of a Disputes that is the subject matter of the Conciliation proceedings except that a Party may initiate arbitral or judicial proceedings where, in his opinion, such proceedings are necessary for preserving his rights including for preventing expiry of period of limitation. Unless terminated as per the provisions of this Scheme, the Conciliation proceedings shall continue notwithstanding the commencement of the arbitral or judicial proceedings and the arbitral or judicial proceedings shall be primarily for the purpose of preserving rights including preventing expiry of period of limitation.

34. The official language of Conciliation proceedings under this Scheme shall be English unless the Parties agree to some other language.

FORMAT-5

STATEMENT OF CLAIMS/COUNTER CLAIMS TO BE SUBMITTED TO THE IEC BY BOTH THE PARTIES

1. Chronology of the Disputes

2. Brief of the Contract/MoU/Agreement/LOI/LOA

3. Brief history of the Disputes:

4. Issues:

5. Details of Clam(s)/Counter Claim(s):

SI. No.	**Description of claim(s)/Counter Claim**	**Amount (in INR)Or currency applicable in the contract**	**Relevant contract clause**

6. Basis/Ground of claim(s)/counter claim(s) (along with relevant clause of contract)

Note– *The Statement of Claims/Counter Claims may ideally be restricted to maximum limit of 20 pages. Relevant documents may be compiled and submitted along with the statement of Claims/Counter Claims. The statement of Claims/Counter Claims is to be submitted to all IEC members and to the other party by post as well as by email.*

FORMAT-7

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY BHEL FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,

M/s. (Stakeholder's name)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY BHEL**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which arise out of the above- referred Contract/MoU/Agreement/LOI/LOA are reproduced hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring disputes to conciliation.

In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby seek your consent to refer the matter to Conciliation by Independent Experts Committee to be appointed by BHEL. You are invited to provide your consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which you might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA.

Please note that upon receipt of your consent in writing within 30 days of the date of receipt of this letter by you, BHEL shall appoint suitable person(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of BHEL

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-8

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY A STAKEHOLDER FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,
BHEL (Head of the Unit/Division/Region/Business Group)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY A STAKEHOLDER**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which have arisen out of the above-referred Contract/MoU/Agreement/LOI/LOA are enumerated hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring inter-se disputes of the Parties to conciliation.

We wish to refer the above-said disputes to Conciliation as per the said Clause of the captioned Contract/MoU/Agreement/LOI/ LOA. In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby invite BHEL to provide its consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which it might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA and to appoint suitable person(s) as Conciliator(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of the Stakeholder

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-9

FORMAT FOR INTIMATION TO THE STAKEHOLDER ABOUT APPOINTMENT OF CONCILIATOR/IEC

To,

M/s. (Stakeholder's name)

Subject: **INTIMATION BY BHEL TO THE STAKEHOLDER AND CONCILIATOR(S) ABOUT APPOINTMENT OF CONCILIATOR/IEC**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Sir,

This is with reference to letter dated ---------- regarding reference of the disputes arising in connection with the subject Contract No /MoU/Agreement/LOI/LOA to conciliation and appointment of Conciliator(s).

In pursuance of the said letter, the said disputes are assigned to conciliation and the following persons are nominated as Conciliator(s) for conciliating and assisting the Parties to amicably resolve the disputes in terms of the Arbitration & Conciliation Act, 1996 and the Procedure ---- to the subject Contract ...../MoU/Agreement/LOI/LOA, if possible.

Name and contact details of Conciliator(s)

a) .....

b) .....

c) .....

You are requested to submit the Statement of Claims or Counter-Claims (strike off whichever is inapplicable) before the Conciliator(s) in Format 5 (enclosed herewith) as per the time limit as prescribed by the Conciliator(s).

Yours faithfully,

Representative of BHEL

CC: To Conciliator(s)… for Kind Information please.
Encl: As above

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.