VOLUME – IA
PART I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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VOLUME – IA - TECHNICAL CONDITIONS OF CONTRACT

PART I - CONTRACT SPECIFIC DETAILS

VOLUME-IA PART – I CHAPTER – I

PROJECT INFORMATION

1.1.1 INTRODUCTION

2 x 700 MWe PHWR – Kaiga-5&6 Atomic Power Project is being set up by Nuclear Power Corporation of India Ltd. (NPCIL) at Kaiga Village, Karwar Taluka, Uttara Kannada District, Karnataka, India. Kaiga Site is at about 13 km upstream of Kadra Dam and associated hydro-electric power house on the left bank of Kali River on the banks of the Kadra reservoir. It is suggested that Bidder shall necessarily acquaint himself by a visit to the site and with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

1.1.2 PROJECT INFORMATION

1	Name of the Project	2 X 700 MWe PHWR – Kaiga-5&6 Atomic Power Project
2	Station Capacity	2 X 700 MWe
3	Owner	Nuclear Power Corporation of India Ltd. (NPCIL)
4	Site Location	Kaiga, Uttara Kannada District, Karnataka. About 53 km from Karwar (Konkan Railway) Station and NH 10 passes through Karwar
5	Nearest Railway Station	Karwar (Konkan Railway)
6	Nearest Airport	Goa – 140 kms
7	Accessibility	Kaiga site is accessible from Karwar through State Highway 06 (SH-06) by taking 3 km diversion from SH06 at Hartuga. SH-06 is interconnected with SH 34 at Kadra and NH-66 at Karwar. Hence the nearby towns like Dharward, Hubballi, Belgaum, Goa etc. is connected. The nearest Broad gauge rail connectivity exists at Karwar on Konkan Railway and Londa on Belgaum-Goa broad gauge of South Western Railway Division. Air connectivity exists with Goa, Hubballi

<table>
<tr><td></td><td></td><td>and Belagavi at 140, 150 and 175 kilometre respectively from Kaiga Site</td></tr>
<tr><td>8</td><td>Ambient Air Temperature</td><td></td></tr>
<tr><td>A</td><td>Max. Dry Bulb Temperature</td><td>+ 41.6 Deg.C</td></tr>
<tr><td>B</td><td>Min. Dry Bulb Temperature</td><td>10.9 Deg.C</td></tr>
<tr><td>C</td><td>Design temperature for electrical equipment / devices</td><td>+ 50 Deg.C</td></tr>
<tr><td>9</td><td>Relative Humidity</td><td>i. Maximum during monsoon 99.9 %
ii. Minimum(design) 3%
iii. Performance 50 %</td></tr>
<tr><td>10</td><td>Air Quality</td><td>Clean and free from chemical pollutants.</td></tr>
<tr><td>11</td><td>Rainfall</td><td>a) Annual Average: 3649.31 mm
b) Highest annual rainfall: 4695.1 mm in 1988
c) Lowest annual rainfall: 2345.3 mm in 2016
d) Period: Year 1987-2017
Average rainfall of 3900 mm during the four months of monsoon (June to September)</td></tr>
<tr><td>13</td><td>Wind Pressures</td><td><table><tr><td>Height above mean ground level, m</td><td>Design Wind Speed m/sec</td></tr><tr><td>@ 10 M</td><td>5.0</td></tr><tr><td>@ 100 M</td><td>13.8</td></tr></table>The assessment of wind loads based on the above basic wind speed shall be done as specified in IS: 875.
Wind direction: Predominantly W, SW, NE & E with respect to true North</td></tr>
<tr><td>14</td><td>Seismology</td><td>Zone III as per IS1893-2002 part I</td></tr>
</table>

VOLUME-IA PART – I CHAPTER – II

SCOPE OF WORKS

1.2.1 The scope of works covers **Civil, Structural and Architectural Works of Turbine Island Package of 2 X 700 MWe PHWR Kaiga Atomic Power Project - Unit 5 & 6**, Uttara Kannada District, Karnataka including, supply of all materials (excluding the materials supplied by BHEL free of cost), labour, equipments, tools and plants etc. complete as per specification, drawing and as directed by engineer- in-charge.

1.2.2 **The list of buildings/ structures in the package is mentioned below. However, the scope of work is indicative only, but not limited to the given below,**

1. Turbine Building
2. Turbo Generator Foundations and deck slab
3. BFP and other Pumps foundations
4. Access bridge
5. Local control room
6. Annex building
7. Workshop
8. Misc. structural steel work of Electrical building
9. Chemical Lab
10. Condenser Cooling Water (CCW) pipe/conduit
11. Tunnel and Trenches
12. Transformer Yard including oil pit
13. Pipe and Cable Bridge and Pedestals
14. Foundation of all equipments
15. Turbine oil storage tank
16. Embedded parts/Penetrations
17. Condensate Storage Tank (CST) area
18. Steam generator blowdown (SGBD) area
19. Pipe encasing
20. Peripheral drain
21. Gas cylinder room
22. Platforms in reactor building

23. Pipe & Cable (PC) Bay
24. Miscellaneous platform etc.
25. ETP sump pits
26. Plinth protection
27. Paving and underground works
28. Sewage Network, Drains
29. Storm Water Drainage System, Culverts
30. Plumbing and Sanitary works
31. Miscellaneous foundations for equipment, pumps, skids
32. Portable sheds
33. Area grading and access roads etc.
34. Civil work of fire protection system

NOTE: The above provided scope of work is indicative only for the bidder's guideline. **Any other building/ structure/ foundation not mentioned above, but required for completion of the work 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 no. 2.15.7 of GCC.

1.2.3 BHEL shall provide Cement, Reinforcement steel and Structural steel for civil and structural works only for incorporation in the permanent works as free supply. Embedment's /inserts required for the works in general shall be supplied by the bidder and payment shall be made as per corresponding item in BOQ. If BHEL provides Structural Steel for embedment's/inserts from scraps (if available), payment shall be made as per corresponding item in BOQ. If BHEL provides fabricated embedment's/ inserts as supplied by BHEL manufacturing units, payment for fixing of those shall be made as per corresponding item in BOQ.

1.2.4 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 (petroleum, oil, lubricants, etc.), transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. The earthwork and all other allied works are included in the rates of items of work.

1.2.5 Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, preparation of fabrication drawings etc. are included on the rates of items of work. Works shall only be carried out with approved structural fabrication drawings.

1.2.6 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.

1.2.7 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.

1.2.8 The unit rates shall include all material, equipment, fixtures, labour, tools & plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.

1.2.9 All the BOQ Item rates shall be inclusive of customer's requirements for sampling and testing of construction material, preparation of construction methodology, working drawings and scheme, details of erection methods, safety manual, job hazard analysis and work procedure.

1.2.10 Contractor shall coordinate in preparation and submission of construction completion certificate & transfer docket containing necessary documents like test certificate, inspection reports etc. and obtaining approval from BHEL/NPCIL as per specification and as directed by engineer - in – charge.

1.2.11 It is the responsibility of the Contractor to coordinate in preparation, obtaining approval and ensure compliance with the quality assurance requirement of BHEL/NPCIL. For this purpose, Contractor shall have appropriate quality assurance organisation and have personnel with requisite qualification to carry out inspection /quality surveillance.

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

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

1.2.14 Contractor shall note that BHEL is liable to its customer (NPCIL) for following all norms and guidelines regarding safety and housekeeping as specified in the tender or as provided by NPCIL during course of execution of contract. Inter-Alia, BHEL's contractor deployed at NPCIL site will also be regulated under the same norms/guidelines and has to provide all safety and housekeeping requirement as specified by customer (time-to-time). In case of contractor's failure to provide such materials/ services and consequently if any penalty/recovery is imposed by Customer (NPCIL), same will be recovered from the due payments (Bills) of the contractor.

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

1.2.16 For further detailed scope of work, refer relevant chapters in the technical specification.

VOLUME-IA PART – I CHAPTER – III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR/ BHEL

SCOPE MATRIX

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.1.0	**ESTABLISHMENT**			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		Free
B	Open space for storage/T&P	Yes		
C	Construction of bidder's office, canteen and storage building 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	
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE SUCCESSFUL BIDDER'S PERSONNEL			
A	Open space for labour colony		Yes	
B	Living Accommodation		Yes	
1.3.1.2.0	**ELECTRICITY**			
1.3.1.2.1	Electricity for construction purposes			
1.3.1.2.1.1	Single point source (in general) For detail, refer clause no. 1.3.4	Yes		Chargeable See clause 1.3.4
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
1.3.1.2.2	Electricity for the office, stores, canteen, labour colony, etc. of the bidder which include:		Yes	
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
1.3.1.2.2.4	Demobilization of the facilities after completion of works		Yes	
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc. on the above lines		Yes	
1.3.1.3.0	**WATER SUPPLY**			
1.3.1.3.1	For construction purposes:			
1.3.1.3.1.1	Making the water available at single point		Yes	Refer clause 1.3.5.
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.3.2	Water supply for bidder's office, stores, canteen, labour colony, etc.		Yes	
1.3.1.3.2.1	Making the water available at single point		Yes	
1.3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.4.0	**LIGHTING**			
1.3.1.4.1	For construction work (supply of all the necessary materials) • At office storage area • At the construction site / area • At the labour hutment		Yes	
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) • At office storage area • At the construction site /area • At the labour hutment		Yes	
1.3.1.5.0	**COMMUNICATION FACILITIES for site operations of the bidder**			
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc.		Yes	
1.3.1.6.0	**TRANSPORTATION**			
1.3.1.6.1	For site personnel of the bidder		Yes	

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.6.2	For bidder's equipments and consumables (T&P, Consumables etc.)		Yes	
1.3.1.7.0	**DEMOBILIZATION OF ALL THE ABOVE FACILITIES**		Yes	
1.3.1.8.0	**Arranging of gate pass for workers from M/s NPCIL which requires Police verification certificate, Medical certificate and copy of Aadhaar card as per NPCIL procedure**		**YES**	

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
	CONSTRUCTION FACILITIES			
1.3.2.1.0	**Engineering works for construction**			
1.3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		
1.3.2.1.2	Drawings for construction methods		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	"
1.3.2.1.4	Shipping lists etc for reference and planning the activities	Yes	Yes	"
1.3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL as per requirement of BHEL targets
1.3.2.1.6	Review of performance (Form-14) and revision of site construction schedules in order to achieve the end dates and other commitments			
1.3.2.1.7	Weekly construction schedules based on Sl No 1.3.2.1.5			
1.3.2.1.8	Daily construction / work plan based on Sl No 1.3.2.1.7			For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	

Sl.No	Description	Scope to be taken care by		Remarks
	PART II	BHEL	Bidder	
1.3.2.1.10	Preparation of Fabrication shop and preassembly bay as per NPCIL requirement		Yes	

1.3.3. OPEN SPACE

1.3.3.1. To establish a temporary site office and storage area at the job site, minimum open space will be provided as made available by customer.

1.3.3.2. Location and area requirement for office / storage sheds shall be discussed and mutually agreed to after award of work at site. Construction of necessary stores and storage of materials shall be in contractor's scope. Security of stores & work place shall be in Contractor's scope.

1.3.3.3. It is the responsibility of the contractor to construct fabrication shop for reinforcement and structural steel, Grit blasting and painting shops, provide all utilities and dismantle and clear the site after completion of work or as and when required, as a part of his scope of work.

1.3.3.4. Availability of land is very limited and the contractor has to plan and use the existing land considering the use of land by other contractors and the storage of plant machineries and materials. 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. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

1.3.3.5. BHEL shall not provide to the contractor any residential accommodation to any of his staff and labourer and the contractor has to make his own arrangements at his cost.

1.3.3.6. Also, contractor shall establish workers canteen at site for the use of labourers engaged by him.

1.3.4. ELECTRICITY

1.3.4.1. In general, Construction power will be provided to the contractor at prevailing rates of NPCIL on chargeable basis at one single point by BHEL. The contractor has to provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc. However, based on request of Contractor and requirement of project, BHEL Site in charge, at his discretion, may provide construction power at multiple point (as close to work area as possible), on chargeable basis, for smooth execution of the work at site. If, BHEL provides electricity at more than one point (as

close to work area as possible), it will be responsibility of the contractor to provide all the support necessary for enabling BHEL for extending such provision to contractor. The contractor has to provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc.

Prevailing rate of NPCIL for Construction Power Supply is Rs. 5.00 per kWh.

1.3.4.2. Necessary "Capacitor Banks" to improve the Power factor to a minimum of 0.9 shall be provided by the contractor at his cost. On account of the contractor's failure in maintaining the power factor at 0.9, penalty if any, levied by customer will be recovered from contractor's bills. Currently, this penalty will be surcharge @ 1% of energy charges for every 0.01 fall in average power factor.

1.3.4.3. The contractors/ consumers shall install suitable power factor improving device and a trivectometer for calculation of Power Factor with Maximum Demand. In case contractor fails to provide trivectometer. NPCIL/BHEL will consider P.F. at their connection as 0.6.

1.3.4.4. The bidder irrespective of connected load must have following minimum Electrical protection for Over current, Earth fault and Short circuit on their panel. Bidders have to provide soft starters for motor loads 100 KW and above.

1.3.4.5. Provision of distribution of electrical power from the given points 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.

1.3.4.6. The bidders shall follow AERB safety guide /site procedures of NPCIL.

1.3.4.7. BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.

1.3.4.8. In case of non-availability of construction power, the contractor shall make their own arrangements for their construction power/electricity requirements to have uninterrupted work. Also, as there are bound to be interruptions in regular power supply, power cut/load shedding as 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 any contingency arrangement made by contractor, due to delay / failure in providing electricity.

1.3.4.9. It shall be the responsibility of the contractor to provide and maintain their complete electrical installation with due regard to safety requirements at site. All cabling and installations shall be subject to the approval of the Engineer/ Safety Engineer and shall comply in all respects to the appropriate statutory requirements.

For this purpose, the contractor shall provide full specifications of the equipment and the layout drawings. Approval of the Engineer does not absolve the contractor from complying with any or all other conditions laid down herein.

1.3.4.10. The power supply shall be subject to all such restrictions and regulations currently in existence and as may be enforced by the NPCIL/ Government/ State Electricity Board/ or by any other competent authority from time to time for which the contractor will not have any claim whatsoever.

1.3.4.11. Electricity for labour colony shall be arranged by the contractor at his cost.

1.3.5. WATER

1.3.5.1. Boreholes for drawal of water shall not be permitted in the plant area for KAIGA-5&6.

1.3.5.2. Water source for Construction Water (Raw Water) is available within 2Km from project site. Contractor shall make his own arrangement for drawing water from this source.

1.3.5.3. Water (Raw water) required for construction purposes will have to be drawn by the contractor and contractor has to make their own arrangement for further distribution by arranging required pipes, valves, pumps, etc. The Contractor shall make adequate arrangement for storage of sufficient quantity of water required for construction work.

1.3.5.4. No charges shall be levied by BHEL/NPCIL for the water drawn and consumed. Any new Royalty or other statutory taxes if any imposed by statutory Authority during the currency of contract shall be reimbursed by BHEL on submission of documentary proof of same.

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

1.3.5.6. Contractor has to make his own arrangements for all water requirement for his labour accommodation at his cost. The Contractor shall make his own arrangement for further necessary distribution of the above at his cost.

1.3.5.7. Contractor has to make his own arrangement for drinking water at his cost.

1.3.6. MATERIAL SUPPLY

Supply / providing aggregate and all other materials as per the technical specification required for the work are in the scope of the contractor. BHEL shall provide Cement, Reinforcement steel and structural steel for civil and structural works only for incorporation in the permanent work as FREE SUPPLY.

1.3.6.1. **Fine aggregate**

Fine aggregate shall conform to requirements of IS 383 and Customer technical specification as applicable. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. Fine aggregate having a specific gravity of less than 2.55 (saturated surface dry condition) shall not be used. Fine aggregate shall be graded within the limits specified in NPCIL's technical specifications. The sand shall be of siliceous material, sharp, hard, strong and durable and shall be free from adherent coating, clay, dust, alkali, organic material, deleterious matter, lumps, etc. Sampling of fine aggregate shall be in accordance with IS: 2430. Fine aggregate shall be so graded that concrete of required workability, density and strength could be produced using the specified water binder ratio. The method of determination of gradation shall be as per IS: 2386. For more details, bidder to refer Technical Specification Section-C.

USE OF CRUSHED SAND

If the contractor desires to replace sand partially or completely, with crushed sand, he may do so only if the quality of final product meets all the requirements of NPCIL's technical specifications. It shall be noted that crushed sand shall be manufactured by specially crushing it from the aggregate by deploying proper machinery for the same. Crusher dust obtained while producing aggregate shall not be directly used for replacing sand unless it meets the technical specifications/ grading limits specified in the technical specification.

1.3.6.2. **Coarse aggregate**

Coarse aggregate for normal concrete shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, vegetation or other

deleterious matter. It shall have no adherent coating. Coarse aggregate shall have an average specific gravity (saturated surface dry condition) 2.6 or more and no individual value shall be less than 2.55. For more details, bidder to refer Technical specification Section-C.

1.3.6.3. **Cement**

Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum each of 100MT capacity per batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the numbers of cement silos shall be increased based on the site requirement. Carrying out design mix required for the scope of work providing all materials except cement is in the scope of bidder. Only cement for the design mix shall be provided by BHEL free of cost. 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.

1.3.6.4. **QUALIFICATIONS AND APPROVAL OF SOURCES**

All materials required for the manufacture of concrete and used for curing of concrete shall be procured only from NPCIL approved sources. The contractor shall also ensure that at least two sources of each material are pre-qualified for ensuring uninterrupted supply of material. Bulk procurement of the ingredients of the concrete shall be made only after the contractor has completed the process of pre-qualification and the Engineer has duly approved the sources/ products.

1.3.6.5. **Reinforcement / Structural Steel**

1.3.6.5.1. The reinforcement steel and structural 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.

1.3.6.5.2. 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.

1.3.6.5.3. Areas of work requiring cut to length steel in order to minimize scrap generation and wastage, has to be identified in consultation with BHEL site engineer and contractor shall furnish the requirement to BHEL well in advance of such requirement.

1.3.6.5.4. If any matching sections of steel are not available with BHEL, contractor may arrange these sections from Customer approved sources and the landing cost of sections to site will be reimbursed based on the prevailing rate at SAIL at the time of procurement at the nearest SAIL outlet with the freight charges against supporting document.

1.3.6.5.5. Bidder to note that steel materials required for Embedment's, inserts, MS Grating, Galvanized Grating, GI Handrail, Stainless Steel Handrail, 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. However, Bidder shall use the scrap materials available with BHEL or with the respective bidders, for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities, if taken from BHEL and shall be accounted for monthly reconciliation, if it belongs to the bidder's scrap materials. However, Bidder shall use the scrap materials available with BHEL or with the respective bidders, for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities, if taken from BHEL and shall be accounted for monthly reconciliation, if it belongs to the bidder's scrap materials.

1.3.7. CONSUMABLES

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. All consumables to be used for the job shall have to be approved by NPCIL / BHEL prior to use.

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

1.3.4 LIGHTING FACILITY:

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

1.3.4.2 Lighting: - Adequate lighting facility in line of Rule- 11 of Atomic Energy (Factories) Rules 1996 for building and outside area such as flood light, hand lights and area fightings shall be provided by the Contractor at his own cost at the site of construction, at the storage of his materials and equipment and at temporary access roads within the working area. The Contractor shall obtain the approval of BHEL Engineer/NPCIL for the lighting arrangement prior to installation.

1.3.5 CONTRACTOR'S OBLIGATION ON COMPLETION:

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

1.3.6 BLASTING

A valid blasting license shall be obtained by the Contractor from authorities concerned for starting any blasting work. The Contractor shall employ a competent and experienced supervisor (called Man-in-Charge) preferably having experience in mining operation and licensed blaster. They shall be held personally responsible to ensure that all safety regulations are followed.

1.3.7 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.

1.3.8. CONTRACTOR'S OBLIGATION ON COMPLETION

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

1.3.9. BID DRAWINGS

Drawings enclosed are only tentative & for information purpose and this may get revised during execution.

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T&Ps TO BE DEPLOYED BY CONTRACTOR

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

1.4.2 The contractor is required to arrange all the major T&Ps and other T&Ps for the satisfactory completion of the work. Below mentioned is a tentative list of T&Ps required and not exhaustive.

A. STRUCTURAL WORKS

Sr No	Major T&Ps	Mobilizing time from the date of start of work
1.	1 Nos. 75 T capacity crawler crane for erection.	As per work requirement at site
2.	1 Nos. 75 T capacity crawler crane for Fabrication	As per work requirement at site
3.	1 Nos. 40 T capacity Tyre mounted crane	As per work requirement at site
	Other T&Ps	**Mobilizing time from the date of start of work**
4.	2 nos. Pick and Carry cranes of minimum capacity 14 T each	As per work requirement at site
5.	2 Nos. Radial drill machine	As per work requirement at site
6.	2 nos. magnetic base drill machine	As per work requirement at site
7.	6 nos. submerged arch welding machine	As per work requirement at site
8.	6 nos. MIG machine	As per work requirement at site
9.	25 nos. welding rectifier	As per work requirement at site
10.	1 no. trailor – 15T	As per work requirement at site
11.	3 no. power driven HSFG bolt tightening m/c	As per work requirement at site
12.	2 no's Power winch – 3T for structural erection	As per work requirement at site

13.	2 no's Power winch – 5T for structural erection	As per work requirement at site
14.	2 nos ultra-sonography machine with recording device for structural work	As per work requirement at site
15.	1 nos. Painting equipment sets complete with compressor, hopper, screen, blasting hose pipe, nozzle airless/conventional spray (within CGI temporary cover shed)	As per work requirement at site

B. CIVIL WORKS

Sr No	Major T&Ps	Mobilizing time from the date of start of work
1.	3 Nos. Tower Cranes of adequate capacity and appropriate height & radius to cover the TG building area along with operator and necessary spares	As per work requirement at site
2.	1 no. automatic concrete batching plant with printing facility (60 Cum/Hr) – and DG backup with minimum 2 Nos of silo (100MT each) per batching plant AND 1 no. automatic concrete batching plant with printing facility (30 Cum/Hr) – and DG backup with minimum 2 Nos of silo (100MT each) per batching plant (Concrete Mixing Plant shall be as per clause 6.6 of Technical specification Section-C)	1 no 60 Cum/Hr Batching plant to be mobilized within 30 days 1 no 30 Cum/Hr Batching plant to be mobilized within 60 days
3.	2 nos. Truck mounted concrete mixer cum pump along with placing boom minimum 36 m high	1 no within 30 days. Balance as per work requirement at site
4.	2 nos. concrete pump (60 cum/ hr min capacity & lift 90M) N.B. – Concrete pump can be replaced by providing additional concrete boom placer of adequate capacity with prior approval of Engineer In-Charge.	1 no within 30 days. Balance as per work requirement at site
5.	Ice Plant for production of ice for temperature control concrete	As per work requirement at site
6.	10 nos. transit mixer (5 or 6 M3 capacity) including standby 2 nos.	5 no within 30 days. Balance as per work requirement at site
7.	1 set of Reinforcement Forging and Threading Machine for Coupler Connections. (Reinforcement Cutting, Forging and Threading Machine should be	As per site requirement

	from the approved supplier/manufacturer of reinforcement coupler by BHEL/NPCIL)	
8.	1 nos. excavator equivalent to capacity of Pocklain CK90	As per work requirement at site
9.	1 no. Vibromax (earth compactor)	As per work requirement at site
	Other T&Ps	**Mobilizing time from the date of start of work**
10.	MS scaffolding pipe / ACROW PIPE	As per work requirement at site
11.	MS scaffolding pipe cup lock system /Doka D3 load bearing tower system.	As per BHEL requirement at site for TG deck
12.	Plywood shuttering board to achieve F-3/U-3 finish in concrete with adequate supporting structure from Doka/Arcow or equivalent	As per work requirement at site
13.	10 nos. Reinforcement cutting machine	As per work requirement at site
14.	20 nos. Reinforcement bending machine	As per work requirement at site
15.	3 nos. Back hoe loader like JCB	As per work requirement at site
16.	5 nos. Vacuum dewatered flooring machine	As per work requirement at site
17.	4 Nos. Dozer	As per work requirement at site
18.	2 nos. power driven earth rammer (Roller Type 1/2 T)	As per work requirement at site
19.	1 no. compression testing machine (200 T cap)	As per work requirement at site
20.	15 nos. Dumpers / Tippers (15 MT/ 20 MT) capacity	4 nos. within 20 days from commencement of work.
21.	Dewatering pumps capacity ranging from minimum 1 HP to 100 HP pumps	As per work requirement at site
22.	1 nos. Wagon Drill	As per work requirement at site
23.	3 nos. Jack Hammer	As per work requirement at site
24.	Air compressor	As per work requirement at site
25.	Concrete vibrator with adequate needle (Minimum 10 nos diesel/power nos.)	As per work requirement at site
26.	Grouting Pump with all accessories and fittings	As per work requirement at site
27.	10 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	As per work requirement at site
28.	1 no. Concrete Paver machine	As per work requirement at site

29.	1 nos. Motorized External Platforms (sky climber)	As per work requirement at site
30.	2 no total station with adequate arrangement for Surveyors.	As per work requirement at site
31.	1 no theodolite 1 second accuracy	As per work requirement at site
32.	6 no's auto level & staff	As per work requirement at site
33.	300 no's concrete cube moulds	As per work requirement at site
34.	Adequate no. of small trucks 2T/5T for shifting of shuttering etc. within site	As per work requirement at site
35.	Water Tanker with Sprinkler	As per work requirement at site
36.	Civil laboratory equipment's as per list in Sl 1.4.7 with temporary building one AC lab room of size 4.5mtr x 6mtr and 1 non AC lab room of size 4.5 mtr x 4.5 mtr. (Laboratory should as per clause 6.14 of Technical specification Section-C)	As per work requirement at site
37.	5 no. drinking water tank – 2000 lit.	As per work requirement at site
38.	10 nos. mobile toilet blocks for labour use.	As per work requirement at site
39.	2 nos. truck mounted 125 KVA DG set	As per work requirement at site
40.	Construction power cable	As per work requirement at site
41.	Construction water Pipeline	As per work requirement at site
42.	Portable fire extinguishers as below: Soda acid – 20 sets. Dry chemical powder – 20 sets CO2 – 20 sets. Water & sand bucket (4 buckets in one stand) – 15 sets. Fire hose with nozzle (50 M length) – 10 sets.	25% within 30 days and balance progressively within 90 days.

Note:

1. T&P shown in the above mentioned list and the mobilization schedule is tentative requirement considering parallel working. 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 will be reviewed time to time at 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. 1.6.1.1 of this specification may please be referred for date of start of work.

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

1.4.4 Contractor shall submit the T&P mobilization schedule indicating the quantity and duration of deployment on monthly basis for the entire contract period in mutual concurrence with BHEL Engineer at the time of commencement of work.

1.4.5 The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing.

1.4.6 The contractor shall establish a state of the art material-testing laboratory at site for testing of all the concrete ingredients, fresh concrete and hardened concrete. Fully automatic cube testing machines of adequate capacity and numbers shall be installed in the laboratory. Facilities for water permeability test as per DIN 1048 and Rapid Chloride Permeability Test (RCPT) as per ASTM-C-1202 shall also be available in the laboratory. Laboratory pan type mixer shall be available with the Contractor.

1.4.7 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.

1.4.8 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 litres 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
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	
SL NO	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**IS REF.**

SOIL TESTING EQUIPMENT				
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

1.4.9 Contractor shall have at all times experienced operators and technicians for routine and breakdown maintenance of the equipment. Any delay in rectification of defects will warrant BHEL rectifying the defect and charging the cost to the contractor.

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

1.4.11 The age of contractor deployed cranes upto 150T 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 BHEL Engineer.

1.4.12 **CRANE OPERATOR FOR CRANES PROVIDED BY CONTRACTOR**

4.12.1 Must be capable of independently operating hydraulic/ mechanical crawler/ tyre mounted cranes of respective categories.

4.12.2 Must have minimum 2 years' experience in operation of hydraulic/ mechanical crawler/ tyre mounted cranes in respective categories & hold valid HMV/TRANS license. Should be able to read and interpret the operation and maintenance manual, boom load chart, boom angle and other indicating devices.

4.12.3 Operator shall have latest physician's certification for their physical fitness in vision with/ without lenses & adequate hearing with or without hearing aid.

1.4.13 **In construction projects of this magnitude all the areas/ approaches might not be ready. In such cases consolidation of ground and arrangement of sleepers/ sand bag filling, construction of Temporary approach road for all their working area etc. for safe operation/ movement of T&P, etc. shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.**

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T&PS PROVIDED BY BHEL ON SHARING BASIS

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

1.5.1 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. n 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.

1.5.2 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.

1.5.3 BHEL may provide either BHEL owned cranes or hired cranes at the discretion of BHEL.

1.5.3.1 In the event of providing BHEL Cranes:

1.5.3.1.1 For all BHEL's own cranes of capacity greater than 150T, BHEL shall provide operators, free of charges.

1.5.3.1.2 Fuel, lubricants and consumables for BHEL's own cranes of capacity greater than 150T, are to be arranged by the contractor within the quoted rates.

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

i. Engine Oil 15 W 40
ii. Fuel Filters
iii. Air Filters
iv. Hydraulic Filters
v. Hydraulic Oil –Servo 68
vi. Gear Oil- Servo 90
vii. Engine oil Filter

viii. Oil Separator Filter

ix. Rope- CRG 100 Grease

x. Grease- Servo Multi-Purpose Grease

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

1.5.3.2 In the event of providing hired Cranes:

1.5.3.2.1 Crane operators for hired cranes will be provided by BHEL, on free of charges.

1.5.3.2.2 The fuel for the crane is to be arranged by the contractor.

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TIME SCHEDULE

1.6.1 **TIME SCHEDULE**

1.6.1.1 The commencement of work at site shall be mutually agreed date between bidder and BHEL to start the work.

1.6.1.2 The entire scope of work shall be completed within **32 (Thirty-two) months** from the date of commencement of work at site with intermediate milestones as mentioned in clause no. 1.6.7.4.

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

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

1.6.2 **MOBILISATION**

1.6.2.1 The Contractor has to subsequently augment his resources in such a manner to achieve the COMPLETION SCHEDULE.

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

1.6.3 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.

1.6.4 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.

1.6.5 **GUARANTEE PERIOD**

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

1.6.6 **SUBMISSION OF L3 SCHEDULE**

The contractor shall submit a detailed L3 schedule within 15 days in consultation with BHEL based on the tentative schedule provided as per the clause 1.6.7. The schedule shall be approved by BHEL and the same shall be implemented. Bidder shall submit the detailed schedule in MS Projects to meet the agreed project schedule covering various mile stone 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.

1.6.7 **CONSTRUCTION SCHEDULE**

1.6.7.1 The tentative construction schedule for the scope of works for both Units is as mentioned below:

Sl. No.	Area	Description	Completion Month from the date of commencement of civil work (Tentative)	
			Unit#5	Unit#6
1	Commencement	Commencement of Civil Works	1	4
2	TG Foundation	Construction of Raft	4	7
3		TG Columns (Including condenser pedestal)	14	17
4		TG Deck	19	22
5		Finishing Works (Including Aux Columns)	22	25
6	Turbine Building	Construction of Raft (Inc CEP, BFP, Vacuum Pumps)	3	6
7		Tunnels & Trenches	8	11
8		Construction of floor at EL 100.0 m	14	17
9		Construction of floor at EL 111.0 m	17	20
10		Construction of floor at EL 118.0 m	20	23
11		Finishing works	24	27
12	Electrical Building	Construction upto EL 100 m	11	14
13		Construction above 100 m	18	21
14		backfilling & Finishing works	23	26
15	Pipe & Cable bridge (PCB)	Construction of foundation	8	11
16		Construction upto EL 100 m	14	17

Sl. No.	Area	Description	Completion Month from the date of commencement of civil work (Tentative)	
			Unit#5	Unit#6
17		Construction above 100 m	19	22
18	Access Bridge (AB) between Turbine Building & Control Building	Construction upto EL 100 m	15	18
19		Construction above 100 m	20	23
20	Transformer Yard	Construction of Transformer Yard & other equipment foundations including bus duct, rail foundation, BOP	11	14
21		Construction of GT foundation	16	19
22		Construction of UT foundation	17	20
23		Construction of SUT foundation	17	20
24		Finishing works	19	22
25	Annex Building	Construction upto EL 100 m	15	18
26		Construction above 100 m	20	23
27		Backfilling & Finishing works	22	25
28	Erection of O&M Platforms	Erection of O&M Platforms	26	29
29	Final Bill & Completion			32

1.6.7.2 The above schedule is tentative and 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.

1.6.7.3 The major activities as mentioned against the work schedule given in Clause No.1.6.7.1 are to be indicated in detailed schedule which will be prepared by the bidder.

1.6.7.4 **INTERMEDIATE MILESTONES**

Intermediate milestones are as below.

S No	Description	Completion month from the date of commencement of civil work (Tentative)	Intermediate Milestone
1	Completion of Construction of Turbine Building floor at EL 100.0 m Unit # 5	14th Month	M1
2	Completion of TG Deck Unit # 6	22nd month	M2

1.6.7.5 Penalty for Intermediate Milestones

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

1.6.7.5.2 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.

1.6.7.5.3 In case 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.

1.6.7.5.4 In case 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.

1.6.7.5.5 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.

1.6.7.5.6 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.

1.6.7.5.7 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.

1.6.7.5.8 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.

1.6.7.5.9 Note: *Executable contract value-value of work for which inputs/fronts were made available to contractor and were scheduled for execution till the date of achievement of that milestone.

1.6.7.6 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.

1.6.7.7 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.

1.6.8 **RECORDS TO BE MAINTAINED AT SITE:**

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 manufacturer's test certificates

VII. Records of disposal of soil/ rock generated during and after the work completion.

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

IX. List of T&Ps and MMEs

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TERMS OF PAYMENT

1.7.0 TERMS OF PAYMENT

1.7.1 ADVANCE FOR MOBILIZATION

1.7.1.1 Following will be the breakup for payment of Interest Free Mobilization advance, limited to maximum of 5 % of the contract value, as per GCC clause 2.13.1

T&Ps to be mobilised	% split-up
Back hoe loader like JCB– 2 Nos	0.25
Batching Plant – 60 cum/hr. capacity– 1 No. with 2 Nos of silo (100MT each)	0.75
Transit mixer– 4 Nos	0.2
Concrete boom placer– 1 No	0.25
Tower cane – 1 No	0.75
Batching Plant – 30 cum/hr. capacity – 1 No. with 2 Nos of silo (100MT each)	0.75
Concrete boom placer– 1 No	0.25
Concrete pumps – 1 No. (Deployment of concrete boom placer is allowed in lieu of concrete pump)	0.25
Transit mixer – 2 Nos	0.1
Civil Laboratory with AC – 1 No	0.25
75 T capacity crawler crane for Fabrication – 1 Nos	0.15
Tower cane – 1 No	0.75
Reinforcement cutting machine- 10 nos.	0.1
Reinforcement bending machine - 20 nos.	0.1

1.7.1.2 Payment of advance shall be as mentioned above and recovery of the advance will be as per clause 2.13 of GCC.

1.7.2 INTERIM PAYMENT

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

1.7.2.2 95% item rate shall be released after completion of works certification by Engineer in charge.

1.7.2.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.

1.7.2.4 Retention amount shall be as per Clause no. 2.22 of General Conditions of Contract (GCC).

1.7.2.5 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.

1.7.3 ROYALTY / SEIGNIORAGE CHARGES

Royalty/ seigniorage charges for excavation outside the plant boundary, as applicable as per Govt. of Karnataka for earth work shall be payable by the bidder at bidder's cost and proof of payment shall be submitted to BHEL along with each RAB. The above royalty/ seigniorage charges shall be inclusive within the quoted rate. No extra payment shall be applicable to the vendor.

1.7.4 METHOD OF MEASUREMENT

Mode of measurement shall be as per relevant IS 1200 in conjunction of IS code 3385. In case the same is not available, the standard procedure adopted in CPWD shall be adopted. 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.

1.7.5 PERFORMANCE BOND TOWARDS WATERPROOFING OF UNDERGROUND STRUCTURES

1.7.5.1 Contractor shall make periodical inspection and repair the waterproofing for any apparent defects to ensure complete waterproofing during the guarantee period of 10 years. The Contractor shall submit a Bank Guarantee from a scheduled commercial bank (other than co-operative bank) for an amount of 10% of the cost of water proofing works carried out. The bank Guarantee shall be valid for a period of ten (10) years from the date of acceptance of the water proofing work by NPCIL.

1.7.6 PERFORMANCE BOND TOWARDS ROOF INSULATION AND WATERPROOFING

1.7.6.1 The Contractor shall be responsible for maintaining the roof top insulation for a period of 10 years from the date of acceptance of the water proofing work by NPCIL. The Contractor shall make periodical inspection especially before start of the rainy season and repair the waterproofing for any apparent defects to ensure effectiveness of water proofing during the guarantee period.

1.7.6.2 The Contractor shall submit a bank guarantee from a scheduled commercial bank (other than co-operative bank) for 10% of the cost of roof insulation and water proofing works carried out. The bank Guarantee shall be valid for a period of five years from the date of acceptance of the water proofing work by NPCIL.

1.7.7 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.

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TAXES AND DUTIES

1.8.1 All taxes and duty other than GST & Cess and BOCW Cess

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

1.8.2 Goods and service Tax (GST) & Cess –

For GST Registered bidder:

1.8.2.1 The successful bidder shall furnish proof of GST registration under GST Law, covering the supply and 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. The bidder to specify in their offer the category of registration under GST i.e. Regular dealer or composite dealer**.**

1.8.2.2 Bidder's price/rates shall be exclusive of GST & Compensation Cess (herein after termed as GST).

1.8.2.3 This scope of work covered under Works contract services or other services, hence related GST rate shall be applicable (presently 18%).

1.8.2.4 Vendor / Contractor is required to ensure that all benefits as per existing laws have been considered.

1.8.2.5 Price quoted by the composite dealer shall be considered as inclusive of GST. In the event of any change in the status of vendor / Contractor from composite to regular dealer after the submission of the bid but before completion of supply of services or goods, Contract value shall be amended to remove the embedded GST and any ITC benefit arising due to change of status, which shall be passed on to BHEL. GST paid on the amended contract value shall be reimbursed at actuals against the Tax invoice if BHEL is able to take input tax credit. However, no reimbursement of GST shall be made if BHEL is not able to take input tax credit. The decision of BHEL in this regard will be final and binding on the vendor/contractor.

1.8.2.6 It is the responsibility of the vendor / contractor to adhere to all the provisions of E- Invoicing under GST Act (if applicable). As per the E-Invoicing provisions vendor / Contractor has to generate IRN and QR Code from the E-Invoicing system and the same need to be printed in the invoice submitted to their customer. Invoices that do not comply to the above requirements, will not be accepted by BHEL. If the successful Bidder is not falling under the preview of E-Invoicing, then he has to submit a declaration in that respect along with relevant financial statements. However, applicability of E-invoicing, shall be verified from the E-Invoicing portal on submission of vendor / Contractor GSTN. BHEL shall reimburse GST only if all the provisions of E-invoicing are complied with.

1.8.2.7 It is the responsibility of the vendor/ Contractor to issue the Tax Invoice strictly as per the format prescribed under the GST Act within the prescribed time period in order to enable BHEL to avail input tax credit within the due date. Invoices shall be submitted on time to the concerned BHEL Engineer In-Charge. Tax invoice should also contain below details

a. Contractor Name and Contact details.
b. GST No of Contractor
c. PAN No of Contractor
d. Document Type: Tax Invoice/ Debit Note/ Credit Note
e. Category: B2B / B2C (B2B is only applicable w.r.t BHEL)
f. Customer Name and Contact details / Bill To Details (as mentioned below)
g. Unique Tax Invoice Number
h. Invoice Date
i. IRN No, QR Code, Acknowledgment No and Acknowledgment Date generated from E-Invoice Portal as per E-invoicing provisions under GST Act (If applicable)
j. Place of Supply (as mentioned below)
k. Description of service provided
l. 8 Digit SAC code
m. GST Rate
n. Gross value of Invoice
o. Taxable Value
p. Tax / GST Amount
q. Total Invoice value including GST.

Above are inclusive and not exhaustive list of requirements.

1.8.2.8 Bidder should mention the “Bill To “and “Place of supply” as below in the Tax Invoice

Bill To:
2 X 700 MWe PHWR 3 Kaiga-5&6 Atomic
Power Project Kaiga, Uttara Kannada District.
State: Karnataka
GSTN of BHEL: ----------

Place of Supply:
2 X 700 MWe PHWR 3 Kaiga-5&6 Atomic
Power Project Kaiga, Uttara Kannada District.
State: Karnataka
GSTN of BHEL: ----------

1.8.2.9 The amount equivalent to the GST amount shall be withheld from the vendor / contractor payments towards non-compliance of GST/ Statutory provisions if below requirements are not satisfied:

a. Vendor / Contractor submitted original copy of Tax invoice /debit note as per the prescribed format under the GST act within the prescribed time period in order to enable BHEL to avail input tax credit within the due date.

b. The details of the invoice or debit note referred to in clause (a) has been furnished/filed by the Vendor/ Contractor in the statement of outward supplies (presently in GSTR1 or IFF) and such details get reflected in the BHEL GST login (Presently in GSTR 2B) in the manner specified under GST Act.

c. Details of vendor/contractor invoice reflected in BHEL GST login should match with the details in the tax invoice submitted by the vendor/contractor (Like Invoice no, Invoice date, GSTN, Place of supply).

d. The tax charged in the invoice /debit note referred to in clause (a) has been has been actually paid to the Government, either in cash or through utilization of input tax credit admissible by the Vendor/ Contractor.

1.8.2.10 In case, any GST credit is delayed/denied to BHEL or BHEL has to incur any liability (like interest / penalty) due to non/delayed receipt of goods or submission of tax invoice after the expiry of timeline prescribed in the relevant GST Act for availing ITC, or any other reasons not attributable to BHEL, Then the same shall be recovered from the vendor/contractor along with interest levied/ leviable on BHEL.

1.8.2.11 GST shall be levied on recoveries, wherever applicable and same shall be recovered from payments. BHEL shall issue / raise Tax invoice on contractor/vendors for such recoveries.

1.8.2.12 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 Vendor / Contractor themselves. BHEL shall not issue or raise any Road Permit/ E- Way Bill for this purpose. Any claim or demand raised by the GST department for non- generation / non submission of E-way bill shall be to the contractor/ vendor account

1.8.2.13 BHEL shall not reimburse any expenditure incurred by the contractor towards demand, additional liability or interest / penalty etc., raised by the GST department due to issues such as wrong rates / wrong classification of services or goods.

1.8.2.14 Where GST is payable by BHEL under reverse charge basis, any demand raised or any interest or penalty levied / leviable by the GST department due to non-submission or delayed submission of invoice by the contractor or for any other reason not attributable to BHEL, the same shall be recovered from the vendor/contractor.

1.8.2.15 Tax Deduction at Source (TDS) as per Sec 51 of the CGST Act shall be deducted (if applicable). GST TDS certificate in Form GSTR -7A shall be issued to be contractor. However, GST TDS certificate can be generated only if the contractor accepts the TDS details uploaded by BHEL and files his return. If any specific exemption from GST TDS is applicable to any contractor/vendor, then a declaration to that effect along with relevant documents as may be required by BHEL, substantiating such exemption in line with GST law provisions or notification, shall be submitted by the vendor/contractor.

For GST Unregistered bidder:

1.8.2.16 In case, bidder is not required to register under Goods and service Tax (GST) & Cess, the same is to be specified in the offer.

1.8.2.17 Successful bidder to furnish a Self-declaration that registration under GST is not required or not applicable as per the provisions of GST Law along with relevant document and provisions in the GST law.

1.8.2.18 In case BHEL has to incur any liability (like interest / penalty etc.) due to non- compliance of GST law in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.

1.8.2.19 TDS under GST (as & when applicable) shall be deducted at prevailing rates on gross invoice value.

1.8.2.20 If RCM is made applicable at a later date, GST will be paid by BHEL to the department at applicable rate treating the quoted the price as inclusive of GST if BHEL is not able to take Input tax credit.

1.8.2.21 In the event of any change in the status of bidder from unregistered to registered under the GST law after the submission of bid but before the completion of supply of services or goods, the same need to be intimated and all the clauses applicable for Registered bidder need to be followed. The vendor/ contractor is required to pass on the ITC benefit arising due to change of status, to BHEL. Contract value shall be amended accordingly. GST paid on the amended contract value shall be reimbursed at actuals against the Tax invoice only if BHEL is able to take input tax credit.

1.8.3 Statutory Variations

1.8.3.1 In general, Statutory variation for GST is payable to the Vendor/Contractor during the contract period including extension thereof. Further, for period beyond the contract period, BHEL will reimburse the actual applicable tax even if the same is higher than the amount applicable within the contractual period in case BHEL is able to take the input tax credit. However, the decision of BHEL in this regard will be final and binding on the vendor/contractor otherwise vendor/contractor has to bear the differential upward increase in tax and quoted price is to be adjusted accordingly.

1.8.3.2 No other variations except GST shall be payable by BHEL.

1.8.4 New Taxes/Levies –

In case Government imposes any new levy / tax after submission of bid during the tenure of the contract, BHEL shall reimburse the same at actual on submission of documentary proof of payment subject to the satisfaction of BHEL that such new levy / tax is applicable to this contract. However, Contractor/ Vendor shall obtain prior approval from BHEL before depositing new taxes and duties. Any benefits arise out of new tax levies and/or abolition of existing taxes must be passed on to BHEL. The decision of BHEL in this regard will be final and binding on the vendor/contractor.

1.8.5 Direct Tax

1.8.5.1 Vendor/ Contractor is required to update himself on its own and comply with provisions of Indian Income Tax Act as notified from time to time. Purchaser shall not be liable towards liability of income tax accruing to the vendor/contractor of whatever nature including variations thereof, arising out of this Order/ Contract, as well as tax liability of the vendor/ Contractor and his personnel.

1.8.5.2 Deductions of Tax at source as per Income Tax Act, at the prevailing rates shall be effected by the Purchaser before release of payment, as a statutory obligation, if applicable. TDS certificate will be issued by the Purchaser as per the statutory provisions. The Vendor/Contractor has to mention their Permanent Account Number (PAN) and GSTIN in all invoices.

1.8.6 BOCW Act & BOCW Welfare Cess Act

1.8.6.1 Contractor's price/rates shall be exclusive of BOCW Cess.

1.8.6.2 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.

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

1.8.6.4 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.

1.8.6.5 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.

1.8.6.6 Contractor shall make remittance of the BOCW cess as per the Act in consultation with BHEL as per the rates in force (presently 1%). BOCW remittance should be made only after obtaining prior consent from BHEL. 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.

1.8.6.7 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.

VOLUME-IA PART – I CHAPTER - IX

BILL OF QUANTITY (BOQ)

1.9.1 Bidders shall only quote "Total amount" in the format given in the price bid. Any other elsewhere in the price bid shall be treated as Null and Void.

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

1.9.3 BHEL has the pre-fixed the weightages for the amount of individual items of Bill of Quantity with respect to the "Total amount".

1.9.4 Based on the pre-fixed weightages, the amount for the individual items of the Bill of Quantity shall be arrived at. This amount shall be rounded off to the nearest rupee.

1.9.5 Based on the quantities of individual item and the amount arrived in Clause No. 1.9.4 above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.

1.9.6 Bidder to note that this is an item rate contract. Payment shall be made for the actual quantities of work executed as certified by BHEL Engineer at the unit rate arrived at as per Clause No. 1.9.5 above.

1.9.7 Quantity variation shall be as per GCC Clause no. 2.14 & modification in GCC mentioned in the tender.

1.9.8 Only brief description of items of work is given in the PRICE SCHEDULE. All the works are to be done as per tender specifications, descriptive notes and drawings to establish the complete facilities in all respects.

VOLUME-IA PART – I CHAPTER - X

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.)

1.10.1 Successful Bidder is requested to furnish the following at PSSR-HQ Chennai immediately after release of Letter of Intent (LOI)

i) Security Deposit

ii) Unqualified Acceptance for LOI, Detailed LOI / Work Order.

iii) Rs.100/- Stamp Paper for preparation of Contract Agreement.

1.10.2 Successful Bidder are requested to furnish the proof of documents for the following at the respective PSSR- Site

i) PF Regn No.

ii) Labour License No.

iii) Workmen Insurance Policy No.

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

1.10.3 PROVIDENT FUND

1.10.3.1 The contractor is required to extend 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 the 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.

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

1.10.4 OTHER STATUTORY REQUIREMENTS

1.10.4.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules and Valid WC Insurance copy or ESI Code (if applicable) and PF code no. along with the first running bill.

1.10.4.2 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.

1.10.4.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of "Non-compliance of Sec 21 or non-payment of wages" to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.10.4.4 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.

1.10.4.5 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.

1.10.4.6 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.

1.10.5 DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN

The following clause is applicable in case the contract value / contract price is Rs. Five crores and above.

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

1.10.6 Site Visit by the Bidder

1.10.6.1 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.

1.10.6.2 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.

1.10.6.3 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.

1.10.6.4 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.

1.10.6.5 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.

1.10.6.6 All works shall be carried out in proper workmen like manner. Items of works covered by the following specification shall be carried out as per the best practices and according to the direction of the Engineer In- charge / BHEL, Site Engineer and to his satisfaction. Unless otherwise specified in this section or in the description of item, the cost of stage of works mentioned here under shall be deemed to have been included in the rates of items provided in the schedule.

1.10.6.7 Scope of work covered under this specification requires quality workmanship, engineering and green belt management along with the supply of all consumables, tools and tackles and testing instruments. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments etc. in his possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled personnel. The manpower deployment identified by contractor shall match with above scope of works.

1.10.6.8 It is not the intent to specify herein all details of all material. Any item related this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work.

1.10.6.9 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there at no extra cost.

1.10.6.10 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.

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

1.10.6.12 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.

1.10.6.13 Wherever work sequences are furnished by BHEL, the contractor shall follow the same sequence.

1.10.6.14 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. The contractor shall co-operate with other contractors and agencies so that various activities can be carried out simultaneously in order to achieve an early completion.

1.10.6.15 Contractor shall execute the supply and works as per sequence prescribed by BHEL at site engineer. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of execution of similar job in any other site or for any reasons whatsoever.

1.10.6.16 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.

1.10.6.17 Contractor shall, transport all materials to site and unload at site / working area for inspection and checking. All material handling equipment required shall be arranged by the contractor.

1.10.6.18 Contractor shall retain all T&P / Testing instrument / Material handling equipments etc at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.

1.10.6.19 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.

1.10.6.20 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 work agreed will be subject to the condition that contractor's work is not hampered by the agencies.

1.10.6.21 Contractor has to work in close co-ordination with other work 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 work program have to be planned in such a way that the milestones are achieved as per schedule/ plans. Contractor shall arrange & augment the resources accordingly.

1.10.6.22 The contractor must obtain the signature and permission of the security personnel of the customer for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside.

1.10.6.23 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.

1.10.6.24 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.

1.10.6.25 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe / tubes, and handrails etc for any temporary supporting or scaffolding works. Contractor shall arrange himself all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.

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

1.10.6.27 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on ISO 9001 – 2008 Standards.

1.10.6.28 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.

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

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

1.10.6.31 It is the responsibility of the contractor to do the checking, testing etc. if necessary, repeatedly to satisfy BHEL Engineer with all the necessary tools and tackles, manpower etc. without any extra cost. The testing will be completed only when jointly certified so, by the BHEL Engineer.

1.10.6.32 If any item or equipment not covered but requires being executed, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.

1.10.6.33 The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities will be penalized and contractor shall be responsible for cost for such damages.

1.10.7 SITE INSPECTION

1.10.7.1 BHEL or his authorized agents may inspect various stages of work during the currency of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.

1.10.7.2 BHEL will have full power and authority to inspect the works at any time, either on the site or at the contractor's premises. The contractor shall arrange every facility and assistance to carry out such inspection. On no account will the contractor be allowed to proceed with work of any type unless such work has been inspected and entries are made in the site inspection register by BHEL.

1.10.7.3 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, leading to delay in execution of work or any other matter, BHEL shall have the right to engage labour at normal ruling rates and get the work executed through other agency and debit the cost to the contractor and the contractor shall have no right to claim compensation thereof. In such a case, BHEL shall have the right to utilize the materials and tools brought by the contractors for the same work.

1.10.8 DOCUMENTATION

1.10.8.1 The following information shall be furnished by the bidder within two weeks of award of contract for purchaser's approval:

1.10.8.2 Bar chart covering planned activities at site

a. Detailed organization chart

b. Details of T&P available with contractors with documents proofs.

1.10.8.3 The following information shall be furnished by the bidder after testing and inspection:

Test certificates of various tests conducted at site. All inspection and test certificates shall be signed by BHEL representative also.

1.10.9 RECORDS TO BE MAINTAINED AT SITE:

1.10.9.1 Record of Quantity of FREE/Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.

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

a. Hindrance Register.

b. Site Order Book.

c. Test Check of measurements.

d. Supply and Consumption Daily Register of Cement and Steel

e. Records of Test reports of Field tests.

f. Records of manufacture's test certificates.

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

VOLUME-IA PART – I CHAPTER - XI

PROGRESS OF WORK

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

1.11.0 PROGRESS AND MONITORING OF WORK

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

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

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

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

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

a) Colour Progress photographs to accompany the report should be submitted.
b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.
c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan.

d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane operators, store keepers, lab technicians, helpers, security, etc. Data will be spilt up under the work area.

e) Consumables report giving consumption of all types of gases and electrodes during the previous month.

f) Availability report of cranes/ T&Ps

g) Safety implementation report in the format

h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.

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

1.11.7 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.

1.11.8 It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, labour availability, equipment deployment, testing, etc.

1.11.9 The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.

1.11.10 The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

VOLUME-IA PART – I CHAPTER – XII

MATERIAL HANDLING

1.12.1 Open land as available shall be provided by BHEL on free of cost basis as provided by NPCIL. 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 nearer plant premises 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 cost.

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

1.12.3 Periodic audit of system of purchasing, storing and issue, etc. will have to be carried out by the vendors. BHEL will also audit the same.

1.12.4 The contractor shall construct waterproof cement store (capacity 400 MT) for initial period for storing and stacking of cement, CGI/ asbestos roofing (slope) with brick masonry wall, PCC flooring. Materials required for the same shall be provided by contractor at his own cost. Cement has to be kept over wooden raised platform. Stacking of cement is to be done as per IS codes with proper illumination and locking arrangements.

1.12.5 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.

1.12.6 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.

1.12.7 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of computerized reconciliation statement of such account to the BHEL with each running bill.

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

1.12.9 All structural steel (issued for insert/ embedment) shall be stacked plate size wise and thickness wise. Beams, channels and angles shall be stacked separately on sleepers.

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

VOLUME 1A PART-1 CHAPTER XIII

ACCOUNTING OF MATERIALS ISSUE

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

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

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

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

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

1.13.3 SCRAP & SERVICEABLE MATERIALS

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

1.13.4 RECONCILIATION OF MATERIALS

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

1.13.5 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.

13.2.1 PENAL RATE OF MATERIALS

1.	**REINFORCEMENT STEEL** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod	**Rs. 59,085 per MT** + GST and/or other taxes & duties
2.	**STRUCTURAL STEEL**	**Rs. 70,124 per MT** + GST and/or other taxes & duties
3.	**CEMENT**	**Rs. 6,563 per MT** + GST and/or other taxes & duties

VOLUME-IA PART – I CHAPTER - XIV

ENTRY OF CONTRACTOR'S PERSONNEL AND VEHICLES

1.14.1 The construction site is within the purview of authorized security force. The contractor shall follow at site all security rules as may be framed by the Corporation from time to time regarding removal/movement of materials and equipment from site, issue of biometry RFID identity cards, control of entry of personnel and all similar matters. Contractor shall also follow all rules and regulations applicable to the area being declared / pronounced from time to time by the authorities or state authority having sensitive structures within the vicinity of the site. Nothing extra will be payable on account of stoppage/hindrance of the work.

1.14.2 The contractor shall get the gate passes for their workers issued by Security agency deployed by NPCIL.

1.14.3 The identity cards/passes will be issued to the Contractor's staff and labour by NPCIL. A refundable amount as notified from time to time by NPCIL, shall be charged for issuing these cards. However, all such cards shall be essentially retuned back to NPCIL on completion of work or when the individual card holder leaves the site.

1.14.4 In case contract workers leave in between i.e. before the expiry of contract completion date, the contactor must inform the same to EIC & Security agency so that suitable remark can be added in the computer record for future checking. The contractor has to ensure deposition of gate pass issued to such worker to issuing authority through Engineer-In-Charge at the earliest.

1.14.5 In general, RFID cards with hand geometry shall be applicable for all the contract personnel and workmen. However, till the system for issue of RFID cards with hand geometry is established for, normal photo gate passes shall be issued. In case of damage or loss of RFID card a penalty of Rs. 200/- per card shall be imposed and recovered from the RA bill.

1.14.6 **Procedure for issue of gate pass is as below:**

i. Temporary passes will be issued for an initial period of 15 days on the basis of photo identity on recommendation of Engineer-In-Charge based on request & certification of contractor.

Following forms of photo identity shall be acceptable for issue of initial gate passes to contract personnel and workmen.

a. Voter ID card / Diving License / Passport /Photo bearing ration card/Aadhar Card

b. Letter from the following in their letter head with attested photo and individual's details

- Village Administrative officer
- Elected Councilor
- Panchayat President
- Member of Legislature Assembly (MLA)
- Member of Legislature Council (MLC)
- Member of Parliament (MP)
- Tehsildar

ii. Thereafter, renewal of above temporary gate passes will be done for a period of further two months after having completed safety induction training, first aid training and submission of medical fitness certificate.

iii. The Contractor shall submit the **police verification certificate (PVC)** for his staff and labour as a pre-condition to issue of RFID cards. On receipt of PVC,

RFID card shall be issued upto a period of one year or remaining contract period, whichever is less. In between, each of contractor's employee has to undergo safety training after every 6 months, which shall be coordinated by contractor's Head (IS&F) & NPCIL Head (IS&F)]. After expiry of this one-year duration, gate passes shall be further renewed as per the same guidelines.

iv. In case of receipt of any adverse information against an individual, the issued identity card shall be immediately cancelled and contractor has to surrender it with Security Agency.

v. Separate permission will have to be obtained by Contractor for entry of personnel, equipment's & material in night shift and also for Sunday / Holidays.

1.14.7 Permission for vehicles will be given for a period of six months or expiry of contract, whichever is earlier based on the recommendation of Engineer-In-Charge, after verification of relevant documents.

1.14.8 The contractor and his employees shall not disclose any information or drawings furnished to them by the Corporation. Any drawings, reports and other information prepared by the contractor/by the Corporation or jointly by both for the execution of the contract shall not be

disclosed without the prior written approval of the Engineer. No photographs of the works or plant within the site premises shall be taken.

1.14.9 On completion of work, contractor has to surrender all identity cards issued under the contract for their labour / staff to Issuing authority and a No Dues Certificate has to be submitted to Engineer-in-Charge of work before final bill payment.

VOLUME-IA PART – I CHAPTER - XV

HOUSEKEEPING

1.15.1 Housekeeping is very essential to provide safe working area for construction personnel and for movement of the machineries. In order to achieve this objective; a two part housekeeping policy is adopted at Kaiga-5&6. As first part, Contractor has to maintain certain housekeeping practices for his own works. In addition to this, for up keeping of overall plant area and areas where multiple agencies work simultaneously, different package Contractors shall be responsible for maintaining general housekeeping in the allocated specific area to them.

Scope of work under these two parts is detailed as below. No separate payment shall be made for this work and its cost to be included in the price bid.

1.15.2 **Housekeeping of own works**:

1) The Contractor shall at all-time keep his work spot, site office, workshops and surroundings clean and tidy from rubbish, scrap, surplus materials and unwanted tools and equipment.
2) Welding and other electrical cables shall be so routed to allow safe traffic by all concerned. Cables shall not be spread on floor; it shall be properly supported and clamped along the wall.
3) 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 Engineer-In- Charge may require the Contractor to remove any materials which are considered to be of danger or cause inconvenience to the public. In case Contractor fails to comply with the instruction of Engineer-In-Charge, he may get the work done at the risk and cost of Contractor.
4) The Contractor shall on day to day basis have removed from the work place all unwanted scaffoldings, surplus materials, rubbish, etc.
5) The Engineer-In-Charge has the right to stop work if the Contractor fails to improve upon the housekeeping after having been notified.
6) In addition, the Contractor shall comply with specific housekeeping requirements given in the tender specification.

1.15.3 **Housekeeping of the assigned area / Building:**

During the entire phase of execution of contract till facilities are taken over by BHEL/NPCIL (which also includes extended period of contract, if any), it shall be the responsibility of the

Contractor to maintain general cleanliness in the area assigned to him. The contractor shall estimate the total area for two nos. of turbine building based on the approved final layout.

1.15.3.1 General description of work

SL. NO.	OPERATION	MINIMUM FREQUENCY OF OPERATION
1.	Cleaning and Sweeping of all floors, staircase, platform, lifts and wiping of handrails, equipment, JBs, pipes and etc.	Daily
2.	Wet mopping of finished floors	Weekly
3.	Vacuum cleaning of finished floors	Monthly
4.	Debris removal from dust bin, baskets placed in the respective building.	Monthly or as and when required

1.15.3.2 **Procedures for execution of work:**

1) Cleaning and sweeping of floors, staircase, platform, anything and everything up to ceiling height and ceiling, as per the frequency indicated in the table. Cleaning activity shall start in the morning at 7.00 AM so as to complete all the cleaning/ moping work before 9.00 AM.
2) Continuous sweeping to be done at entrance of building and cleaning/ wiping of equipment and systems located at various floors of the building during working hours with lunch break and tea break.
3) Removal of cobwebs, putting the collected debris other than structural materials in the dustbin kept at the specified location on every day basis. Disposal of collected structural materials within a distance of 1.5 Km on daily basis
4) Lifting, carrying and disposal of all generated debris such as structural pieces, cable pieces, cable trays, ducts, wooden pieces, packing materials, piping material etc. and all other generated scrap from allotted building within a distance of 1 Km on daily basis.
5) Disposal of debris from dust bins/baskets placed in the respective building within a distance of 1 Km once in a monthly basis or as and when required.
6) In order to maintain quality services and minimize operational problems, the contractor must rotate the staff once in six months with prior written intimation to Engineer In Charge.

7) The Contractor shall arrange his own equipment's and tools required for this work like trolleys, ladders, buckets, dust bins, brooms, industrial vaccum cleaner, brushes, wiping cloths or any other material required for the cleaning.
8) The storage and security of his materials and equipment shall be the sole responsibility of the Contractor and shall have no right to claim for any loss/theft or damage of the same.
9) The exclusive work force shall be deputed for this work and work force deployed for this general housekeeping shall not be diverted for any other job or for his own house keeping jobs.
10) All deployed work force shall be provided with dress (with proper code), safety and cleaning gears and in no case work should stop for want of gears.
11) The Contractor shall make his own arrangements of water required to execute this job.

1.15.3.3 **Providing work force / staff:**

The Contractor shall deploy adequate housekeeping and supervisory manpower at his own account & responsibility. At the time of allotment of the area for up keeping, the name of NPCIL officials in charge for housekeeping, herein after referred as "Area in charge" (AIC) of the area will be conveyed to the Contractor.

1.15.3.4 **Reporting:**

1) The Housekeeping Supervisor(s) should report daily to the AIC & take day-to-day instructions
2) The Contractor shall make sure that Housekeeping Supervisor(s) is necessarily available during working hours for receiving & implementing the Instructions of the AIC.
3) It shall be the responsibility of the Contractor to get the attendance of the housekeeping staff verified by AIC.
4) The weekly/fortnightly/monthly jobs should be planned by Housekeeping Supervisor(s) in consultation with AIC in such a manner that these are spread over the entire week and done during office hours.
5) However, certain jobs will necessarily be carried out during Sundays, for which instructions should be taken by the Housekeeping Supervisor(s) from AIC.
6) Proper registers/records of the jobs carried out on daily, weekly, fortnightly and monthly basis will be maintained by the Housekeeping Supervisor(s) and will be countersigned by the AIC on daily basis and finally at the end of each month by EIC.

7) Housekeeping Supervisor shall remain in his area most of the time and shall have information about agencies working/ material stacked in his area. Suitable control system may be devised for the same.
8) The Contractor shall be equipped to handle the special/emergency services even at short notice.
9) All equipment deployed shall be of quality standard.
10) Housekeeping Supervisor shall not allow those materials which affect the up keeping and fire hazards to building. Ex: wooden planks, drums, scaffolding materials which are not painted

1.15.3.5 **Unsatisfactory performance and consequence thereof:**

1) Before commencement of job the Contractor shall submit procedure, manpower list and work plan on housekeeping of respective building under his control and he will follow the same. Monitoring of the levels of Quality of the housekeeping services shall be done on regular basis by BHEL as well as customer's AIC. In the event of unsatisfactory service or any failure at any time on the part of Contractor as reported by Customer (who shall be the sole judge and whose decision shall be final), the Contractor shall be liable to be penalised and accordingly deductions as determined by EIC in a rational manner (finalized by NPCIL) shall be made from the dues of contractor payable against Area housekeeping work.
2) Following penalties shall be imposed for Area House Keeping Work:
    - Non-deployment/Improper maintenance of toilets shall be liable for penalty of Rs. 500 per toilet per day.

    The Contractor shall at all times ensure that his performance is satisfactory, failing which, BHEL shall be at the liberty to get the affected work done through any other agency, at the risk and cost of the Contractor and all expenses incurred on this account shall be recovered from RA bill.

VOLUME-IA PART – I CHAPTER - XIV

SAFETY

1.16.1 In addition to the HSE Obligations and HSE Plan for Site operations by Subcontractors (HSE14 Rev. 02) specified elsewhere in the tender specifications, the contractor will comply with the following:

i. The clauses listed in this chapter

ii. Any other conditions specified by the customer NPCIL

Stringent of the condition(s) stipulated in the above reference shall be applicable to the contractor.

1.16.2 The contractor shall strictly adhere to all the provisions spelt out in the document "AERB Safety Guidelines for Control of Works (guideline no. AERB/NRF/SG/IS Rev 1) and other safety requirements as applicable to the project site.

1.16.3 The contractor shall provide and maintain all lights, fencing, guards, warning signs and caution board and similar items as required ensuring safe working conditions at work site.

1.16.4 Contractor shall comply with the instructions given by the BHEL/NPCIL safety officer regarding safety precautions, protection measures and housekeeping etc.

1.16.5 The contractor shall provide proper access and working platforms for all place of work as per laid down standards or as advised by BHEL/Customer.

1.16.6 The contractor shall ensure that all floor openings in his work are guarded/barricaded during the course of work and at the end of each day's work.

1.16.7 The Contractor shall meet statutory requirements as well as regulatory requirements applicable to the project, in general, and NPCIL in particular, especially the requirements as per Factory Act-1948 (amended in 1987), Atomic Energy factories Rule-1996 (AEFR- 1996 or latest version available at the time of work execution), safety guidelines for Job Hazard Analysis (JHA) & AERB notifications on Industrial & Fire safety.

1.16.8 The contractors' safety professionals shall be well aware about Acts, Rules connected with Industrial Safety and practices particularly applicable to the project and to that effect they have

to undergo an assessment at the project within 15 days of their placement at the project at the cost of the contractor and then only he/she would be given permanent entry pass to plant and considered in the required strength of the safety professionals.

1.16.9 Workers in general shall not be deployed at work for more than I0 hrs/day and in no case more than 12 hrs/day.

1.16.10 All PPE procured and provided to workers shall conform to relevant Indian Standards and should be maintained in healthy condition by suitable storage, maintenance and inspection.

1.16.11 The contractor shall be held responsible for non-compliance of any of the safety measures, injuries, fatalities and compensation arising out of such situations or accidents. Penalty if any on this account levied by the customer will be recovered from the contractor's bills.

1.16.12 Employees Safety & Workmen Compensation:

Contractor shall be responsible for safety of all his employees during execution of the contract work. As per Workmen's Compensation Act, 1923 (Amended in 2000), the contractor will ensure the payment of compensation to his employees in case of an accident as early as possible within the time frame permitted by the law of land.

1.16.13 Safety organization of the contractor

1. Every contractor shall have an Industrial safety organization having qualified safety professionals as enumerated below prior to the execution of job at project. The minimum numbers of safety professionals and their qualifications shall be as per Health, Safety & Environment plan for site operations by Subcontractors (HSEP 14 Rev.02).

2. The above is the minimum requirement of safety professionals. BHEL/NPCIL, if required, can ask for more safety professionals depending upon nature of jobs being executed by the contractor.

3. Contractor's safety professionals shall report to BHEL's safety incharge at plant site. However, administrative control and management of safety in the contract work would be the responsibility of the contractor. Verification of safety professional qualification/competence shall be carried out time to time at site by BHEL/NPCIL. In case contractor fails to employ the required safety professionals, the additional/required safety

professionals may be deployed at the cost and risk of the contractor. The cost incurred towards this shall be deducted from contractor's bill at following the rates.

4. If the required safety professionals are not employed by the contractor, BHEL/NPCIL may deploy such safety professionals and the cost incurred towards this (at the risk and cost of contactor) and any other penalties levied by NPCIL in this regard shall be deducted from the contractor's bills.

1.16.14 Job Supervision at site

1. The contractor must ensure adequate job supervision through educated, qualified and experienced supervisors - at least one supervisor for each hazardous job activity to ensure safety during work execution. Similarly, there should be adequate on-site engineering support ensuring coverage of atleast one experienced engineer for every ten supervisors and part thereof.

2. In case, the contractor is unable to arrange required work supervisors and engineers for work technical support, BHEL/NPCIL may deploy such personnel and the cost incurred towards this (at the risk and cost of contactor) and any other penalties levied by NPCIL in this regard shall be deducted from the contractor's bills.

1.16.15 Training requirements

1. The contractor site-in-charge should arrange induction safety training of four hours duration to all workmen prior to engaging them to work and refresher training on monthly basis covering 20% of the workman in a month with 100% coverage within 6 months. This training should be given with necessary Audio, Visual, Posters aids and as per syllabus approved by NPCIL safety group The training should be in the language understandable to workmen. This training shall include mock trials of wearing of helmet, use of safety belt and it's hooking up to an independent lifeline etc. The safety-training instructor must certify the workmen for having understood safety aspects and use of PPEs successfully in mockup trial. To ensure proper understanding of safety instructions and safety training, the contractor shall employ literate (at least able to read safety instructions) workers only. In exceptional cases of not meeting literacy requirement the workers shall be imparted supplementary training.

2. The job supervisors and the engineers will have to undergo detailed safety training of at least three days' duration at the plant in safety supervision and accident prevention techniques. This training would at the cost of the contractor and then only he/she would be given permanent entry pass to plant.

3. **Contractor must note that in case the industrial safety induction training as per above clause is not conducted within 3 days his workmen shall not get plant entry pass.**

1.16.16 Requirements and specification of PPEs Tools and Tackles

1. Contractor must keep adequate stock of ISI certified (or of relevant international standards) personal protective equipment (PPE), safe working tools and safe working appliances like platforms and access ladders, guard railing etc. corresponding to his scope of work and shall ensure these are used during the job for safe execution of the work. These PPE, Tools and Appliances must be inspected quarterly. Contractor on demand by BHEL/NPCIL Authorities shall produce the record of such inspections.

2. All implements being used for height work like scaffold, access stairs/ladders, platform, railings etc. should be of ISI marked material meeting requirements of AEFR-1996 and should be certified by contractor safety professional prior to its safe use and to the effect that each implement should have display showing it can be safely used. If any workman is found using sub-standard or damaged PPE, tools & appliance, or any unsafe condition/practices is observed, contractor can be penalized as per the charges levied by NPCIL.

1.16.17 Work Practices

1. The Pre Job Briefing, prior to taking up the work, will be carried out by contractor Safety Engineer/Supervisor to all workers using plant guidelines. The Contractor shall make arrangements for adequate and qualified supervision using checklists during the execution of jobs. The contractor shall ensure that all his workmen must take safety permit for each high-risk job as per project procedure.

   If any hazardous work is found without safety work permit/ JHA/ safe working procedure, contractor can be penalized as per the charges levied by NPCIL.

2. Contractor working at height of more than 2.5 meter above stable floor or ground floor must acquire height pass as per procedure including the worker's medical fitness certificate by certifying surgeon (having MBBS qualification) and worker's height qualification etc. If in any height work, the worker is found working without having height pass, contractor can be penalized as per the charges levied by NPCIL.

3. Contractor shall ensure safe movement of man and material as well as vehicles in site premises as per rules/regulations applicable at or issued by plant. In case of violation of the rules/regulation contractor can be penalized as per the charges levied by NPCIL. The decision of the BHEL/NPCIL Engineer-in-charge, with regards to levying penalty in case above work practices are not ensured shall be final and binding.

1.16.18 Safety Plan

1. Contractor at his cost shall perform following tasks for the jobs having high risk as identified by BHEL/NPCIL Safety Group:

   i. Prepare Safe Working Procedures and ensure its implementation in field.
   ii. Carry out Job Hazard Analyses (JHA) and implement in field.
   iii. Based on JHA, the safe working procedures should be modified especially to include checklists as necessary checkpoints for job safety supervision.
   iv. Worker(s) must be trained based on the safe working procedure and explained about DOs & DON'Ts prior to assigning him the job.
   v. The workers must adhere to the safe working procedure for the job.
   vi. Contractor shall ensure that all Tools, Appliances, erecting equipment and their safe use by the contractor work force shall be meeting Indian standards. The contractor must ensure that necessary authorization exist with workmen prior to their deployment on a particular appliance/tool/equipment. The workmen would be required to acquire additional authorization for crane operation, crane signaling, blasting operation, welding and cutting operation, electrical work etc. and then only workmen shall be deployed for such job. He shall maintain all record of tools and equipment for their healthiness and safe use with a copy to BHEL/NPCIL safety group.
   vii. Employing of any sub-contractor by the main contractor shall be with concurrence of plant authorities & Engineer-In-Charge as per applicable procedure of the plant. The main contractor shall ensure that all safety requirements/conditions are effectively

communicated to and well understood by his sub-contractor. The main contractor should ensure safety training & availabilities of required PPEs and he will be responsible for the safety of the workmen of his sub-contractor.

1.16.19 Above clauses should be read in conjunction with relevant clauses elsewhere in the tender conditions and stringent of the condition shall be followed.

1.16.20 If the contractor fails to meet the safety requirements as stipulated under this chapter and mentioned elsewhere in the tender conditions, then penalty as levied by NPCIL will be recovered from the contractor's RA bills.

1.16.21 Penalties for the serious accidents

Following shall be the penalties for each category of serious accidents:

I. For each Serious accident (As per HSEP 14 Rev. 02) – Rs.1,00,000/-

II. For each fatality- Rs. 10,00,000/-

VOLUME-IA PART – I CHAPTER - XVII

QUALITY ASSURANCE

1.17.1 **Quality Assurance Program**

1.17.1.1 The equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Facilities or at his Sub-contractor's premises or at the project site or at any other place of work shall be subjected to quality surveillance commensurate with customer's QA programme to control such activities at all stages necessary, and inspection by the customer's (NPCIL) authorised Quality Surveillance Engineer.

1.17.1.2 The Quality Management System of the contractor shall generally cover, but not limited to the following:

a. His organization structure for the management and implementation of the proposed quality management system including interfaces.
b. Documentation control system.
c. Qualification data for Contractor's key personnel.
d. The procedure for purchase or materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of materials purchased etc.
e. System for construction/fabrication and site erection controls through QA plans.
f. Control of calibration and testing of inspection, measuring and testing equipment
g. System of indication and appraisal of inspection status.
h. System of quality audits.
i. Training, certification and authorization of personnel.
j. System of intimation by the contractor, and approval by the customer of stages of completion of facilities.
k. System for maintenance of records.
l. System for handling, storage, preservation and delivery of items.

1.17.2 The contractor shall also submit a list of all key persons to be engaged in the contract, along with their qualification, experience, organizational position etc.

1.17.3 The Customer's duly authorized representative reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Quality Management and Control Activities of the Contractor/ his vendor.

1.17.4 **Inspection, Testing and Rejection**

1.17.4.1 BHEL's/Customer's Engineer-in-Charge, his duly authorised representative and/or an outside inspection agency acting on behalf of BHEL/Customer shall have at all reasonable times access to the Contractor's premises or facilities and shall have the power at all reasonable times to inspect and examine the materials and workmanship during manufacture or erection and if part of the Stores is being manufactured or assembled at other premises or works, the Contractor shall obtain for the BHEL/NPCIL and for his duly authorised representative permission to inspect as if the Stores were manufactured or assembled on the Contractor's own premises.

1.17.4.2 The Contractor shall give BHEL/Customer Personnel full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility.

1.17.4.3 The Plant and Equipment / Facilities (in part or full) shall be offered by the Contractor for inspection at place of manufacture and/or on the site or at such places as may be specified by the Inspector at the Contractor's risk, expense and cost. The Contractor shall give notice of readiness of Stores/ facilities for inspection to the Inspector and shall perform all tests and inspection in presence of the Inspector as per the terms of the tender specifications and approved inspection plan. In default of such notice, BHEL/NPCIL shall be entitled to appraise the quality and extent thereof.

1.17.4.4 Test Certificates and Guarantee Certificates if required by the Inspector shall be obtained and furnished to him free of cost by the Contractor and/or from the specified agency.

1.17.4.5 The Contractor shall promptly forward to the BHEL/NPCIL duly certified reports of the tests. When the specified tests have been passed, the BHEL/NPCIL shall endorse the Contractor's test certificate, or issue a certificate to him, to that effect.

1.17.4.6 Where consignments are required to be delivered / despatched after inspection by the Inspector as per the Contract, a "Shipping Release" issued by the Inspector shall be enclosed

along with the delivery challan or other shipping documents viz. (Lorry Receipt, Railway Receipt) accompanying the consignments.

1.17.4.7 The Contractor agrees that neither the execution of a test and/or inspection of Plant and Equipment or any part of the Facilities, nor the attendance by the BHEL/Customer or the Engineer-in-charge, nor the issue of any test certificate, shall release the Contractor from any other responsibilities under the Contract.

1.17.4.8 Except as otherwise specified in the Contract, the Contractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Contractor shall agree, with BHEL the time and place for the specified testing of any Plant, Materials and other parts of the Facilities.

1.17.4.9 No part of the facilities shall be covered up or put out of view without the approval of the Engineer-in charge or his authorized representative and the Contractor shall afford full opportunity for examination and measurement of any part of the facilities which is about to be covered up or put out of view and for examination of foundations before permanent work is placed thereon.

1.17.4.10 The Contractor shall give due notice to the Engineer-in-charge or his authorized representative whenever any such part of the facilities or foundation is ready for examination and the Engineer-in-charge or his representative shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such part of the facilities or of examining such foundations. In the event of the failure of the Contractor to give such notice, he shall, if required by the Engineer-in-charge, uncover such work at the Contractor's expense.

1.17.5 **Remedial Work**

1.17.5.1 If it shall appear to the Engineer-in-Charge or his representative at any time during construction or reconstruction or prior to the expiration of the Guarantee Period, that any work has been executed with unsound, imperfect or unskilled workmanship or that any materials or articles provided by the Contractor for execution of the work are unsound or of a quality inferior to that contracted for or otherwise not in accordance with the Contract that any defect, shrinkage or other faults have appeared in the work arising out of defective or improper

materials or workmanship, the Contractor shall, upon receipt of a notice in writing in that behalf from BHEL, forthwith rectify or remove and reconstruct the work so specified in whole or in part, as the case may require or as the case may be and/or remove the materials or articles so specified and provide other proper and suitable materials or articles so specified and provide other proper and suitable materials or articles at his own expense, notwithstanding that the same may have been inadvertently passed, certified and paid for and in the event of his failing to do so within the period to be specified by the Engineer-in-Charge in his notice aforesaid, the Engineer-in- Charge may rectify or remove and re-execute the work and/or remove and replace with others the materials or articles complained of, as the case may be, by other means at the risk and expense of the Contractor.

VOLUME-IA PART-II CHAPTER-I

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

Sl. No.: 01

Following Clauses in General Conditions of Contract (GCC) are modified/ revised/ added:

S.No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
1.	GCC Clause 1.9.1, Sl. No. (ii)	The following mode of deposit, Sl. No. (e) is added: e) Insurance Surety Bonds
2.	GCC Clause 1.10.3, Sl. No. (vi)	**The following Clause, Sl. No. (vi) is deleted**: Security deposit can also be recovered at the rate of 10% of the gross amount progressively from each of the running bills of the contractor till the total amount of the required security deposit is collected. However, in such cases at least 50% of the required Security Deposit, including the EMD, should be deposited in any form as prescribed before start of the work and the balance 50% may be recovered from the running bills as described above
3.	GCC Clause 1.10.3, Sl.No.(vii)	The following mode of deposit, Sl. No. (vii) is added: e) Insurance Surety Bonds
4.	Note mentioned under the GCC Clause 1.10.3	Note mentioned under GCC Clause 1.10.3 is revised as below: Note: **(1)** BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith. **(2)** In case of delay in submission of security deposit, enhanced security deposit which would include interest (Repo rate +4%) for the delayed period, shall be submitted by the bidder.
5.	GCC Clause 1.10.8	**GCC Clause 1.10.8 is revised as below:** 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 (Repo rate+4%) 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
6.	GCC Clause 2.22.1	**GCC Clause 2.22.1 is revised as:** Retention Amount shall be 5% of the Contract Value and shall be furnished through BG in line with clause 1.12 of GCC before payment of first RA Bill. The validity of the said BG shall be initially for the contract period & shall be extended, if so required, up to acceptance of final bill. In case of increase in contract value, additional BG for 5% of differential amount shall be submitted by Contractor before payment of next RA Bill due.

S.No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		Retention Amount can also be recovered at the rate of 10% of the gross amount progressively from each of the running bills of the contractor till the total amount of the required retention amount is collected. In case, contractor opts cash deduction from RA bills in the beginning & subsequently offers to submit BG later on, then refund of deducted retention amount may be permitted against submission of BG for 5% of the Contract Value.
7.	New Clause for "Breach of Contract, Remedies and Termination" is added in place of existing clause of Risk & Cost (i.e. 2.7.2.1 to 2.7.3)	**Clause 2.7.2 and 2.7.3 are revised as:** **2.7.2 <u>Breach of Contract, Remedies and Termination</u>** **2.7.2.1** BHEL shall terminate the contract after due notice of a period of 14 days in any of the following cases, which if not rectified/ improved within the time period mentioned in the notice, then, 'Breach of Contract' will be considered to have been established: i). Contractor's poor progress of the work vis-à-vis execution timeline as stipulated in the Contract, backlog attributable to contractor including unexecuted portion of work does not appear to be executable within balance available period considering its performance of execution. ii). Withdrawal from or abandonment of the work by contractor before completion of the work as per contract. iii). Non-completion of work by the Contractor within scheduled completion period as per Contract or as extended from time to time, for the reasons attributable to the contractor. iv). Repeated failure of contractor in deploying the required resources, to comply the statutory requirements etc. even after given by BHEL is writing. v). Strike or Lockout declared is not settled within a period of one month. vi). Termination of Contract on account of any other reason (s) attributable to Contractor. vii). Assignment, transfer, subletting of Contract without BHEL's written permission. viii). Non-compliance to any contractual condition or any other default attributable to Contractor. **2.7.2.2 <u>Remedies in case of Breach of Contract is established</u>** In case 'Breach of Contract' is established, Security Deposit and Retention Amount shall be encashed/ forfeited. This is without prejudice to BHEL's right to levy of liquidated damages, debarment etc. which shall be applied as per the provisions of the contract. Sequence of recovery to be made in case of breach of contract is established, is as below:

S.No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		a) In case the value of Security Deposit & Retention Amount, available for the Contract, is less than 10% of the Contract Value, the balance amount shall be recovered from dues available in the form of Bills payable to contractor, BGs against the same contract etc. b) Demand notice for deposit of balance recovery amount shall be sent to contractor, if funds are insufficient to effect complete recovery against dues indicated in (a) above. c) If contractor fails to deposit the balance amount to be recovered within the period as prescribed in demand notice, following action shall be taken for balance recovery: i) Dues payable to contractor against other contracts in the same Region shall be considered for recovery. ii) If recovery cannot be made out of dues payable to the contractor as above, balance amount to be recovered, shall be informed to other Regions/Units for making recovery from the Unpaid Bills/Running Bills/SD/BGs/Final Bills of contractor. iii) In-case recoveries are not possible with any of the above available options, Legal action shall be initiated for recovery against contractor. Note: 1) In addition to above, levy of liquidated damages, debarment, termination, short-closure etc. shall be applied as per provisions of the contract. 2) If tendering is done for the balance work, the defaulted contractor (including all the members/partners in case of JV/ partnership firm) shall not be eligible for either executing the balance work or to participate in the tender(s) for executing the balance work. **2.7.3** In case Contractor fails to deploy the resources as per requirement informed by BHEL in writing to expedite the work, BHEL can deploy own/hired/otherwise arranged resources and recover the expenses incurred from the dues payable to contractor. Recoveries shall be actual expenses incurred plus 5% overheads or as defined in TCC.
8.	GCC Clause 2.7.7	**GCC Clause 2.7.7 is revised as:** BHEL may permit or direct contractor to demobilize and remobilize at a future date as intimated by BHEL in case of following situations for reasons other than Force majeure conditions and not attributable to contractor:

S.No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		i) suspension of work(s) at a Project either by BHEL or Customer, or ii) where work comes to a complete halt or reaches a stage wherein worthwhile works cannot be executed and there is no possibility of commencement of work for a period of not less than three months In such cases, charges towards demobilization and remobilization shall be as decided by BHEL after successful remobilization by contractor at site, and decision of BHEL shall be final and binding on the contractor. After remobilization, all conditions as per contract shall become applicable. In case Contractor does not remobilize with adequate resources or does not start the work within the period as intimated, then BHEL reserves the right to terminate the contract and effect remedies under Clause 2.7.2.2. Duration of the contract/time extension shall be revised suitably. In case of any conflict, BHEL decision in this regard shall be final and binding on the contractor.
9.	GCC Clause 2.11.3	**GCC Clause 2.11.3 is revised as:** However, if any 'Time extension' is granted to the contractor to facilitate continuation of work and completion of contract, due to backlog attributable to the contractor alone, then it shall be without prejudice to the rights of BHEL to impose penalty/LD for the delays attributable to the contractor, in addition to any other actions BHEL may wish to take under clause 2.7.2 of GCC i.e. "Breach of Contract, Remedies and Termination".
10.	GCC Clause 2.19.1	**GCC Clause 2.19.1 is revised as:** The contractor will be fully responsible for all disputes and other issues connected with his labour. In the event of the contractor's labour resorting to strike or the Contractor resorting to lockout and if the strike or lockout declared is not settled within a period of one month, it may be considered as 'Breach of Contract' under Clause 2.7 and the remedies under Clause 2.7.2.2 may be executed, at the discretion of BHEL.
11.	GCC Clause 2.24.1	**GCC Clause 2.24.1 is revised as:** Even though the work will be carried out under the supervision of BHEL Engineers the Contractor will be responsible for the quality of the workmanship and shall guarantee the work done for a period of Twelve months from the date of commencement of guarantee period as defined in Technical Conditions of Contract, for good workmanship and shall rectify free of cost all defects due to faulty erection detected during the guarantee period. In the event of the Contractor failing to repair the defective works within the time specified by the Engineer, BHEL may proceed to undertake the repairs of such defective works, by itself, without prejudice to any

S.No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		other rights and recover the cost incurred for the same along with 5% overheads from the Security Deposit.

12. Clause 2.13 of GCC is revised as below:

2.13 SECURED RECOVERABLE ADVANCES:

2.13.1 INTEREST FREE MOBILIZATION ADVANCE: Competent Authority of BHEL may approve proposals for payment of Interest Free Secured Mobilization Advance (limited to a maximum of 5% of the Contract Value) only in Installation Works in Power Plants under exceptional circumstances.

Interest Free Mobilization Advance shall be disbursed in specifically mentioned stages of major resource mobilization in the beginning of the contract, as specified in the TCC, in three or more instalments with the value of any instalment not more than 2.5% of the Contract Value. The next instalment will be due only on completion of the activities linked to the previous instalment.

Each such instalment is to be secured through BG of 100% of the instalment amount.

Recovery of Interest Free Secured Advance shall be made @ 10% of Running Bill Amount. As and when the total recovered amount exceeds any of the BG value submitted against the advance, that BG shall be returned.

In any case, Interest Free Advance shall be fully recovered by the time the contract reaches 50% of the original contract period either from Running Bills or by the Contractor directly depositing the amount. If
the Contractor fails to deposit the total amount by the stipulated date, the recovery shall be made by encashing BGs/ Securities available with BHEL for the balance amount.

2.13.2 INTEREST BEARING ADVANCE:

2.13.2.1 INTEREST BEARING MOBILIZATION ADVANCE: Competent authority may also approve need based Interest Bearing Mobilization advance after a certification from the Contractor for having achieved a financial progress of 10% of the original contract price. However, the total mobilization advance (including Interest Free Mobilization Advance) shall not exceed 10% of the Contract Value. Bank Guarantee towards 'Interest Bearing Recoverable Advance' shall be 110% of the advance so as to enable recovery of not only principle amount but also the interest portion, if so required.

2.13.2.2 INTEREST BEARING SECURED ADDITIONAL INTERIM ADVANCE: In exceptional circumstances, with due justification, Competent Authority of BHEL may approve proposals for payment of additional interim interest bearing advance against Bank Guarantee, for resource augmentation towards expediting work for project implementation. Contractor shall establish

the utilization of advance drawn in the form of Utilization Certificate before the release of next installment.

Bank Guarantee shall be 110% of the advance so as to enable recovery of not only principle amount but also the interest portion, if so required. Unadjusted amount of advances (including Interest Free Mobilization Advance) paid shall not exceed 10% of the total contract value at any point of time.

NOTES for INTEREST BEARING ADVANCE:

(a) Recovery of Interest Bearing Advances shall be made from the Running Bills progressively. Recovery rate per month for Interest Bearing Advances shall be the sum of:

i) Not less than 10% of Running Bill amount

ii) Simple interest up to the date of RA Bill on the outstanding Principle amount/amounts

(b) In any case, Interest Bearing Advance shall be fully recovered by the time the contractor's billing reaches 90% of contract value either from Running Bills or by the Contractor directly depositing the amount. If the Contractor fails to deposit the total amount by the stipulated date, the recovery shall be made by encashing BGs/ Securities available with BHEL for the balance amount along with interest.

(c) Payment and recovery of any of the above advance(s) shall be at the sole discretion of BHEL and shall not be a subject matter of arbitration.

(d) The rate of interest applicable for the above advances shall be the repo rate prevailing on the date of release of advance plus 4%, and such rate will remain fixed till the total advance amount is recovered.

(e) Contractor to submit Bank Guarantee as per prescribed formats for each of the advance and shall be valid for at least one year or the recovery duration whichever is earlier. In case the recovery of dues does not get completed within the aforesaid BG period, the contractor shall renew the BG or submit fresh BG for the outstanding amount, valid for at least one year or the remaining recovery duration whichever is earlier. For each advance, the Contractor will be allowed to submit more than one BG so that the BGs can be returned progressively based on recovered amount. In case, the Contractor prefers to submit single BG against an advance, the amount of BG may be progressively reduced by the amount repaid by the Contractor.

(f) BHEL is entitled to make recovery of the entire outstanding amount in case the contractor fails to comply with the BG requirement.

2.13.3 SECURED ADVANCE AGAINST MATERIAL BROUGHT TO SITE:

Secured advance on the security of materials (which are not combustible, fragile or perishable in nature) brought to the site but not yet incorporated in the works will be made up to 75% of Invoice value, or the 75% of the corresponding value of the materials determined on the basis of BOQ rates, whichever is less, subject to the condition that their quantities are not excessive and shall be used within a period of 90 days and subject to the stipulations, as mentioned below:

(i) Contractor shall obtain prior permission of Engineer-in-charge before procurement of materials against which advance is being sought. Engineer-in-charge shall ensure formal approval of Construction Manager before communicating the permission to Contractor.

(ii) Secured advance shall not be allowed/ payable for materials procured by Contractor before the date of such permission.

(iii) Secured Advance shall be allowed only once against a single invoice. Multiple Secured Advance against single invoice is not allowed.

(iv) Secured advance against materials shall be paid only against non-perishable items. Engineer-in-charge to ensure that such items are adequately covered under insurance cover (to be taken by the Contractor if not covered under BHEL Insurance Policy).

(v) At any point of time, the unadjusted secured payments against material brought to site shall not be more than 5% of the Contract Value.

(vi) The advance will be repaid from each succeeding Running bill(s) to the extent materials for which advance has been previously paid have been incorporated into the works. In any case, such advance payment shall be fully recovered maximum from 3-4 subsequent RA bills whether the material is consumed in the work or not. In absence of sufficient value of RA bills for making the required recovery, the Contractor shall deposit the balance amount. If the Contractor fails to deposit the total amount by the stipulated date, the recovery shall be made by encashing the Securities available with BHEL for the balance amount.

(vii) Contractor has to give a formal deed of hypothecation, drawn up on non-judicial stamp paper under which the BHEL secures a lien on the materials and is safeguarded against losses, due to the contractor postponing the execution of the work or due to the shortage or misuse of materials and against the expenses incurred on their watch and safe custody.

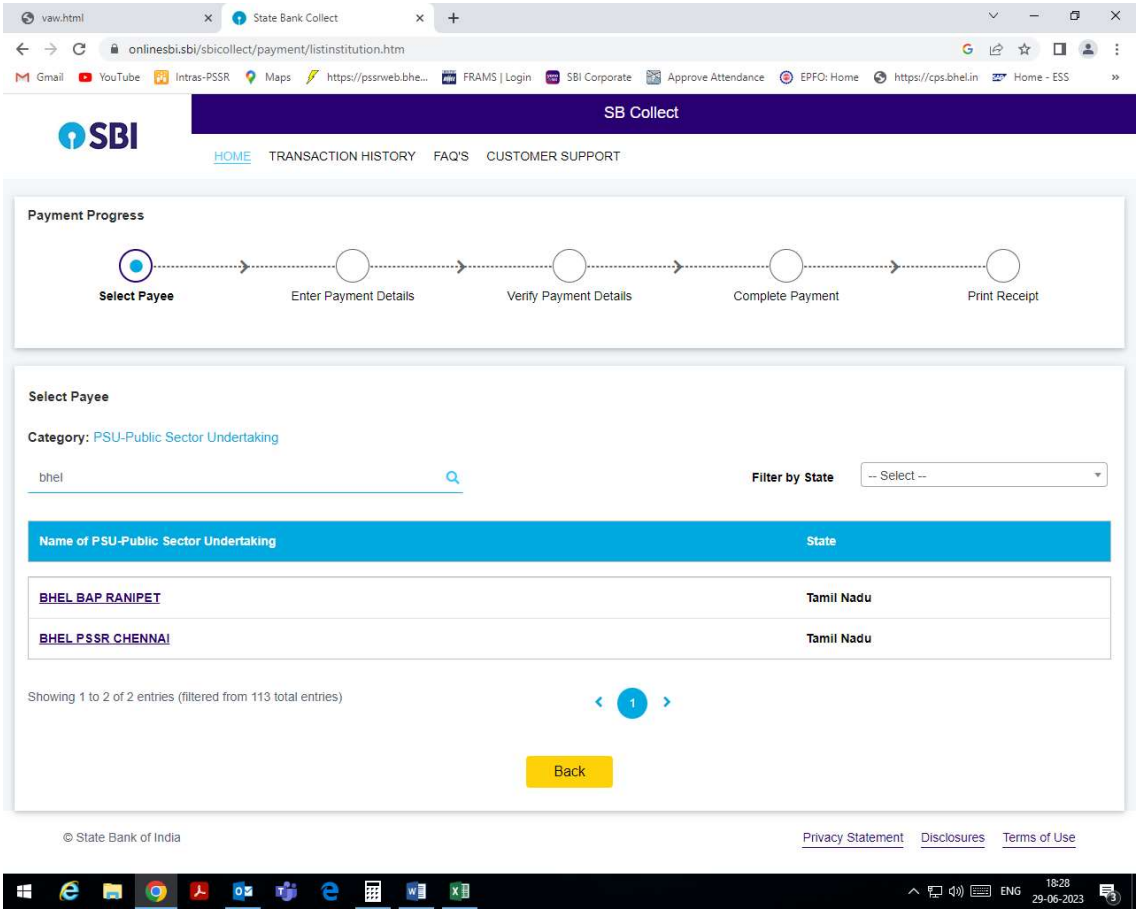
Sl. No.: 02

Detailed Instruction for EMD / Security deposits through SBI e-collect:

Step 1: Vendors may visit SBI collect website, the URL of which is https://www.onlinesbi.sbi/sbicollect where they get the home page with various categories of institutions.

Step 2: Select PSU - Public Sector Undertakings – leading to a page with list of PSUs

Step 3: Type BHEL and search, they get to see all BHEL divisions wherein they shall select BHEL PSSR Chennai. The screen shot of the same is given below.



Step 4: Select EMD receipts. Having selected the Payee in the Payment Progress, it will lead to the payment details – a drop down list of values. From that list, vendors shall select EMD receipts. Upon clicking the entry EMD receipts, a form will open asking for the remitters details and the details of the tender.

Step 5: Confirm details and pay

Fill in all the details correctly, verify the details, and complete the payment as it is leading to the payment gateway.

Step 6: Take a printout on completing the payment and enclose the copy of the same along with the bid submission. Store the copy of receipt for future reference.

Sl. No.: 03

GCC Clause 2.12.3.5 is revised as below:

The maximum amount of ORC payable for the month shall be limited to Rs 10,00,000/-

Sl. No.: 04

GCC Clause 2.15.5 is revised as below:

After eligibility of extra works is established and finally accepted by BHEL engineer/ designer, payment will be released on competent authority's approval at the following rate.

MAN-HOUR RATE FOR ELIGIBLE EXTRA WORKS: Single composite average labour man-hour rate, including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals, consumables for carrying out any major rework/ repairs/ rectification/ modification/ fabrication as certified by site as may arise during the course of erection, testing, commissioning or extra works arising out of transit, storage and erection damages, payment, if found due will be at Rs 139/- per man hour.

Sl. No.: 05

GCC Clause 2.14.1 is revised as below:

2.14.1 Variation in Final Executed Contract Value

The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). No compensation becomes payable in case the variation of the final executed contract value is within the limits of Minus (-)20% of awarded contract value. Also, no compensation becomes payable in case the contract gets partially executed/ short closed/terminated/ work withdrawn under Rights of BHEL mentioned in Clause 2.7 of GCC. In case of work terminated / short closed under clause 2.7.4 of GCC, compensation may be considered only if BHEL receives compensation from customer.

Compensation due to variation of final executed contract value in excess of the limits defined in clause above, shall be as follows:

i) In case the finally executed contract value reduces below the lower limit of awarded Contract Value due to quantity variation specified above, the Contractor will be eligible for compensation @ 15% of the difference between the lower limit of the awarded contract value and the actual executed contract value.
ii) In case the finally executed contract value increases above the awarded Contract Value due to quantity variation, the Contractor is not eligible for any compensation.

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

Sl. No.: 06

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."

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

Sl. no. 07

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

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

S. no. 08

6.3.5 ISSUE OF CEMENT

6.3.5.1 The cement issued by the BHEL shall be properly accounted (issue and reconciliation). Cement as received from the manufacturer/ stockiest will be issued free of cost to the contractor. The cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum each of 100MT capacity per batching plant) to be installed by the bidder nearer to their batching plants. Cement unloading arrangements to silo or stores, in case of cement bags and necessary manpower support shall be provided by the bidder at his own cost.

6.3.5.2 On advance request of the bidder, the cement shall be supplied in 50kg tamper proof sealed Bags for other than RCC works like masonry, flooring works etc. The theoretical weight of each bag of cement for issued purposes will be considered as 50 kg, the contractor shall be accountable for the cement issued to him on this notional weight only. No claim whatsoever will be entertained because of difference between theoretical and actual weight of the bags of cement. The empty cement bags duly accounted for against issue shall be in the custody of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project.

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

6.3.5.4 Bidder is responsible for unloading the cement as soon as the arrival of cement, either in silo, if received in bulker or in the weather proof cement storage sheds, if received bags. Bagged cement shall be stored in a weatherproof sheds having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements (to be made by the contractor at his own cost) 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 within the quoted price. Though the cement is unloaded directly at the contractor storage shed, it will be deemed to be considered that the cement was issued from BHEL stores. Necessary documents are to be submitted by the contractor to BHEL stores for having received cement.

6.3.5.5 The contractor shall satisfy himself of the quality and quantity of supplied cement 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. Bidder is responsible for sampling and testing of cement as per Indian Standard/ Specification/ approved quality plan in the testing laboratory established by the bidder.

6.3.5.6 Bidder is responsible for carrying out design mix as per IS 456/10262 Latest revision and specification, using the cement provided by BHEL and submit the design mix proportions for the approval of BHEL/TANGEDCO. 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.

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

Sl No	***Issue of Materials***	***Max. Qty in Contractor's Store***
1.	Cement	Requirement of one month

VOLUME-IA PART – II

CHAPTERS 2 to 6

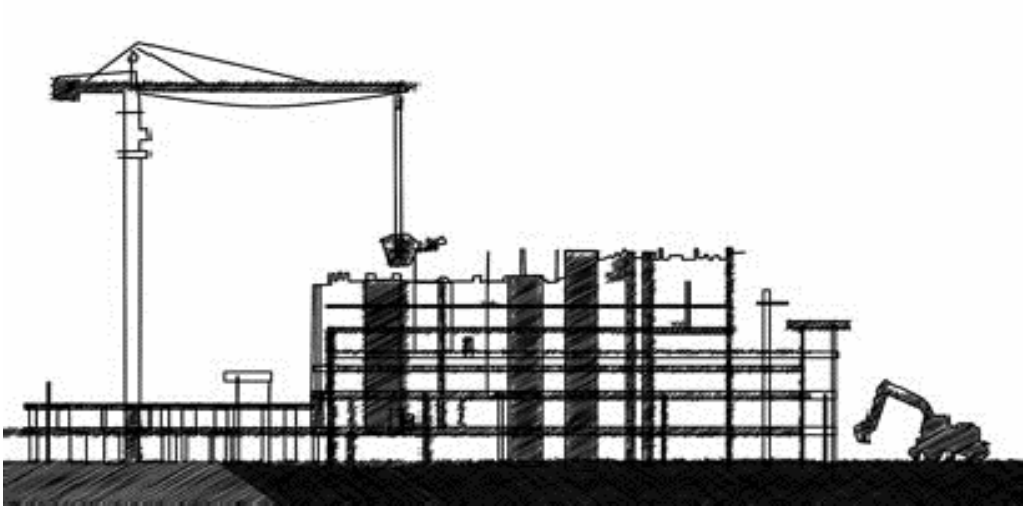
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HSEP14

Health, Safety & Environment Plan for Site Operations by Subcontractors





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C	ANNEXURE C: HSE Tools, Equipment and Devices to be Provided by the Subcontractor	
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E	ANNEXURE E: Minimum Requirements of Labor Accommodation/ Colony	
F	ANNEXURE F: Specifications & Availability for Toilets at Site	
G	ANNEXURE G: Specifications for Numbers and Types of Fire Extinguishers	
H	ANNEXURE H: HSE Compliance Certificate Sample	
I	ANNEXURE I: Detailed Safety Requirements/ Precautions for Various Hazardous Activities/ Conditions	
J	ANNEXURE J: Details & Contents of First-Aid Box	
K	ANNEXURE K: Vertigo Test Procedure	

SECTION A

CRITICAL RESOURCES FOR HSE IMPLEMENTATION

1. SHARING OF OPERATING COSTS OF FACILITIES

TABLE A.1

SN	FACILITY
1	Ambulance with 24 hr. First Aid Trained Driver (Specs in Annexure A)
2	Operation of Medical center, Nurses, Medical Consumables etc. (Specs in Annexure A)
3	Training Center Consumables
4	Water sprinkling for dust suppression
	(Others:)

Note:

i. Responsibility of operation of above facilities shall rest with BHEL
ii. Operating cost of the above shall be deducted from subcontractors on 'proportional to contract' value basis. Sample deduction table enclosed as Annexure A.1
iii. "Contract value" defined above & subsequently in the document shall be considered as "Awarded contract value".
iv. No overhead cost/ enabling cost of BHEL shall be levied on the contractors for common facilities.
v. These running costs shall be recovered from all the available subcontractors at site for the complete operational duration of the site
vi. No overheads shall be charged on shared operating costs

2. RESOURCES TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

TABLE A.2

SN	ITEM	SPECIFICATIONS
1.	HSE DISPLAYS, Posters and signage	Annexure B
2.	HSE Tools/ Equipment/ Devices	Annexure C
3.	Rest Sheds for Workers	Annexure D
4.	Labor Colony	Annexure E
5.	Toilets (Latrines & Urinals) - in Site and Labor Colony	Annexure F
6.	Fire Extinguishers	Annexure G

Note:

In case subcontractor fails to provide the required resources, same will be procured and deployed by BHEL with applicable overhead on total procurement cost

3. ESTABLISHMENT OF COMMON FACILITIES

In green field projects BHEL shall arrange and provide the following facilities which shall be used by all subcontractors for their employees and workers. These shall be

i. Medical Centre
ii. Safety park with facilities of audio-visual training & vertigo test center.
iii. No cost shall be deducted from the subcontractors for the structure part only.
iv. The running cost with basic inputs already mentioned at Point 1 above shall be shared by all contractors.
v. The sub-contractors shall be required to ensure participation in trainings, medical checkup and vertigo test as per the guidelines laid in this document and required as per statutory HSE requirements.

vi. However, in projects where in these facilities are not provided by BHEL, subcontractors shall ensure the training, medical/ vertigo test of all workers at site in consultation and guidance of BHEL HSE team at site in line with provisions of this document.

vii. The overall onus of compliance to HSE practices pertaining to training, medical checkup including vertigo test shall lie on the subcontractor only.

4. CRITICAL REQUIREMENTS W.R.T. EQUIPMENT & PPES

i. Conventional Hydra crane with carriage in front shall not be permitted. Pick & carry tyre mounted Front Cabin mobile crane (FX or TRX/ NextGen series of 'ESCORT" or equivalent make) shall only be permitted.

ii. Any Heavy equipment (cranes, winch machines, etc.) shall be deployed only after pre-safety Inspection by safety dept. Valid AMCs/ Fitness/ other statutory clearances as per local rules shall be required to be submitted before mobilizing the equipment at site.

iii. All other Hand tools and power tools should not be older than 5 years.

iv. For Chimney passenger lift, winch to have double drum rope for passenger and double safety devices must be used. Winch should not more than 3 years old and winch rope must be inspected with valid certificate from competent authority within 6 months and should meet the IS standard 9507 provision of OLR and push back button arrangement or dead man switch.

v. Gate pass for all the lifting T&Ps and construction machinery/ equipment shall be made after obtaining written acceptance (Pre-entry Safety Clearance) from BHEL Site Safety Department after physical verification and checking all requisite documents/ compliance to Safety norms

vi. All motor vehicles should have valid registration certificate, insurance, Pollution under control (PUC) and fitness certificate as per Motor Vehicle Act 2020. The certificates should be pasted in the glass from inside.

vii. PPEs shall be from reputed manufactures viz. 3M, Udyogi, Karam, Frontier, Freedom, Honeywell, Liberty, Bata, Nomex, Acme, Unicare, Life Gear or equivalent. In case Subcontractor recommends any other name the same can be approved at site level by the Construction manager & Site HSE

viii. For height work, where fall could result in death or disability, a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) shall be mandatorily provided by the subcontractor, failing which, a penalty of INR 10000 per case will be imposed. In addition, there should be constant supervision for such critical height work. Any non-erection activities at height eg. Housekeeping etc. shall also fall under the category of height work

ix. **Scaffold Tagging**

Scaffolds being erected, modified or dismantled must be tagged as suitable for use. Tagging shall be done with standard tag holder. Scaffolding tag should be certified by scaffolding inspector having valid certificate.

- **GREEN** scaffold tag- shall be fixed when scaffold is complete and safe for use, signed and dated by the scaffolding competent person daily.
- **RED** scaffold tag – to be fixed if scaffold is in some way defective and cannot be used or is still under erection.
- **YELLOW** scaffold tag – to be fixed if scaffold is in under construction/ maintenance.



FIG. A.4.1 SAMPLE SCAFFOLD TAGS AND TAG HOLDER

x. **T&P Color Coding:**

a. Inspections and tests shall be documented by means of color coding which shall verify that inspections or testing are current and that all receptacles, portable Power tools, Lifting Tools & Tackles have been inspected and tested as required. The color codes used on the project shall be:

GREEN	BLUE	YELLOW	PURPLE
January	April	July	October
February	May	August	November
March	June	September	December

TABLE. A.4.2: T&P COLOR CODES

b. The cycle of colors shall be Quarterly as a minimum or as decided by BHEL. The color code tape / Sticker shall be clearly visible to designate the period for which the inspections and tests were conducted.

c. Following the initial inspection, the equipment must be color-coded quarterly as per color-coding instructions that will be issued by the subcontractor.

d. Fire extinguisher with the current month color-coding inspection sticker must be provided and secured in the platform.

e. All slings shall be regularly inspected in accordance with the requirement of the project for frequent and periodic inspections and discard immediately if they fail to meet the minimum requirements of the project.

f. The Subcontractor's HSE Officer shall ensure that all PPE is inspected prior to its issue. He is to ensure all subcontractor personnel are using safe and proper PPE equipment. Regular

inspections on the PPE shall be carried out and personnel not adhering to those inspections shall be removed immediately from the site.

g. A Ten (10) day interval period shall be given into each monthly color code change. During this Ten (10) day period either color shall be acceptable.

xi. **T&P Tagging:**

All deployed Wire Rope Slings, Chain Pulley Blocks, Hooks, slings etc. shall be Tagged using aluminum or any other metal tag with punching.

5. HSE PERSONNEL TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

5.1. NUMBERS OF HSE PERSONNEL (APPLICABLE FOR EACH WORK SHIFT)

Number of HSE Officers and Supervisors shall be in proportion to number of workers as per Table A.6 below

TABLE A.5

No. of Workers	No. of HSE Supervisors	No. of HSE Officers
Up to 100	1	1
101 to 250	2	1
251 to 500	4	1
501 to 1000	6	2
1000 to 2000	6+ One additional supervisor up to every additional 250 workers	3
2000-3000	10+ One additional supervisor up to every additional 250 workers	4
3000-4000	14+ One additional supervisor up to every additional 250 workers	5

5.1.1. DEPLOYMENT PLAN

i. Above requirement is for every shift for each unit.

ii. The dynamic deployment plan of Safety manpower at various locations containing names, areas, time periods, shifts etc. shall be submitted to BHEL for approval by subcontractor

iii. BHEL may modify the deployment plan based on nature and volume of jobs, Risks and hazards associated etc.

iv. For less than 20 workers HSE Officer is not mandatory. In case the number of workers exceed 20 for 3 consecutive months, HSE Officer is to be engaged. The HSE Officer shall be deployed for a minimum period of 6 months even if the number of workers fall below 20 in any month subsequent to deployment. If within that 6-month period, the number of workers is more than 20 for at least 3 months, the deployment duration of HSE Officer will extend further 6 months after completion of previous 6-month period.

v. For Site Material Management/ Handling (Loading/ Unloading) contracts, 1 no. HSE Officer shall be required irrespective of the total manpower deployed.

vi. HSE Officers/Supervisors of all the vendors may be required to report directly to BHEL HSE Officer at site & shall comprise as a total team for handling all HSE issues. However, each safety officer/ agency shall be individually responsible for the safe execution of work in their respective areas.

5.2. Qualification & Experience Requirements Of HSE Personnel

5.2.1. HSE Officer

First HSE Officer to be mandatorily as per Option I as under and shall be designated Senior HSE Officer. In case of non-availability of HSE Officers with Option I configuration, the subsequent HSE Officers can be as per Option II below with recorded reasons and approval of Site Construction Manager of BHEL. All these deviations should be reported to Region HSE and PSHQ HSE.

A. Option I

i. possesses a recognized degree in any branch of engineering or technology or architecture and had a practical experience of working in a building or other construction work in a supervisory capacity for a period of not less than two years or possesses a recognized diploma in any branch of engineering or technology and has had practical experience of building or other construction work in a supervisory capacity for a period of not less than five years;

ii. possesses a recognized degree or diploma in industrial safety with at least one paper in construction safety (as an elective subject/ part thereof);

iii. has adequate knowledge of the language spoken by majority of building workers from the construction site in which he is to be appointed.

B. Option II:

Graduation Degree in Science with Physics & Chemistry and degree or diploma in Industrial Safety (All Degrees/ Diploma from any Indian institutes recognized by AICTE or State Council of Technical Education of any Indian State) with practical experience of working in a building, plant or other construction works (as HSE Officer, in line with Indian Factories Act, 1958 or BOCW Act, 1996) for a period of not less than five years

Note:

i. HSE Officer as per Option II shall be valid only on availability of Senior HSE Officer as per Option I at site.

ii. In case of resignation of the Senior HSE Officer, the same has to be replaced within 15 days else all subsequent HSE Officers as per Option II (in case of multiple HSE Officers with a single agency) shall not be considered as valid.

iii. The penalty shall be deducted considering non-availability of any HSE Officer at site.

5.2.2. HSE Supervisor: Either of X or Y below

X. Recognized Degree in any branch of Engineering OR Diploma in any branch of engineering with at least one-year construction experience

OR

Y. A recognized graduation Degree in Science (with Physics & Chemistry) or a recognized diploma in Engg. or Tech.

Additional requirements for option (Y) above

i. Trained in fire-fighting as well as in safety / occupational health related subjects, with:
ii. Minimum Two years of practical experience in construction work environment or in the field of safety and

Note:

i. Option a above is by default, b is under special approval from Site HSE & Construction manager
ii. In both cases the candidate should possess requisite skills to deal with construction & fire safety related day-to-day issues.

5.3. HSE In-Charge

In case there is more than one HSE Officer with any subcontractor, one of them, who is senior most by experience & meets qualification as per option 1 as mentioned in clause 2.1 A above (in HSE discipline), may be designated as HSE In-charge who will be the nodal point of contact on HSE matters.

5.4. Supporting Staff To HSE Team

i. Supporting Staff shall include scaffolders, scaffolding inspectors, riggers, skilled and unskilled manpower
ii. Subcontractor shall provide adequate number of workers as and when required, in order to attend and comply to Safety observations raised by BHEL/ Customer.

5.5. Availability And Penalty For Non-Deployment

i. The subcontractor shall submit the certificates of qualification & experience of HSE manpower before deployment for BHEL to assess suitability as per requirement detailed in this document
ii. In case of rejection, subcontractor shall arrange additional candidates and submit resume to BHEL. Penalties will be applicable during the period of non-deployment in such cases as well.
iii. Subcontractor shall ensure physical availability of safety personnel at the place of specific work locations.
iv. The Subcontractor shall deploy the HSE Officers as per the site's requirement. Non-deployment shall lead to stoppage of the work and final decision shall rest with Site HSE & Construction manager.
v. The Subcontractor shall prepare an organization chart identifying the areas of operations, responsibilities and reporting structure of all safety personnel for each shift and submit the same to BHEL.
vi. The subcontractor shall deploy sufficient HSE Officers, supervisors, as per numbers & qualifications mandated in this Section since mobilization of first batch of manpower and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty at following rates:

Non-deployment of HSE Officer –	Rs. 75,000 per man-month
Non-deployment of HSE Supervisor –	Rs. 50,000 per man-month

vii. Penalty shall be collected for the period of non-availability of safety personnel after allowing a grace period of 15 days for finding a replacement. The same shall be deducted on pro-rata basis till the required manpower is deployed.

viii. In case of abnormal delay & frequent rejections of candidates proposed by the subcontractor, BHEL shall exercise the right to deploy the safety manpower & deduct the amount from subcontractor's running bill with applicable overheads. In such cases also, the provision of logistics, transportation, food and other logistical support to the HSE personnel shall be in the scope of subcontractor in addition to the salary. After deployment of manpower by BHEL, the penalty for non-deployment specified above shall not be applicable.

6. COMPETENCY OF OPERATORS/ DRIVERS OF CRANE, WINCH, LIFTING/ CONSTRUCTION EQUIPMENT ETC.

i. The Operators/ Drivers of crane, winch, construction/ lifting equipment etc. shall be experienced and have valid driving license for the class of vehicle / machinery as applicable (like Crane/ Forklift/ Rig, Construction equipment driving license etc.).

ii. Minimum HMV driving license is required for all heavy equipment/ heavy vehicle (trailer/ Hyva /dumper /TM) operators at site.

iii. The subcontractor shall certify competence of these persons in writing as and when they are posted at site.

iv. Crane, Winch, Construction & lifting equipment operator should have certificate on subject course or experience certificate in employer letterhead.

v. Where state is providing license for operating crane, tractor and other construction vehicles, same to be ensured.

Note: In case the statutory requirements i.e. State or Central Acts and / or Rules as applicable like the Building and Other Construction Workers' Regulation of Employment and Conditions of Service- Act,1996 or State Rules (wherever notified), the Factories Act, 1948 or Rules (wherever notified), etc. are more stringent than above, the same shall be followed.

7. In case of any stringent requirement of BHEL's customer over and above the specifications mentioned in current document, the same shall also be required to be complied at site by subcontractor.

8. REFERENCES

The Safety Rules for Construction & Erection as outlined hereunder, while setting out a broad parameter of safety norms, are not exhaustive. The subcontractor and his agencies are advised to refer to the following statutory provisions as amended from time to time for details and strict compliance therewith.

8.1. FOR GREENFIELD PROJECTS

a) Building and Other Construction Workers (regulation of employment and conditions of service) Act, 1996 (briefly referred to as BOCW Act),
b) Building and other construction workers (regulation of employment and conditions of service) Central Rules, 1998 (briefly referred to as BOCW Rules) as adopted by the various State Governments,

8.2. For Expansion, Modification, Alteration and, Or Construction Activity Within An Existing Plant Operating As Per Approved Site Plan Under The Factories Act

a) Factories Act, 1948,
b) Factories Rules, as adopted by the various State Governments
c) BOCW Act
d) BOCW Rules
e) In case a new act/ statutory guideline/ modification/ consolidation of acts is implemented the same shall be required to be adhered by the subcontractor.
f) The latest amendment of the above-mentioned acts/ rules shall be followed at site.

9. BHEL POWER SECTOR HSE MANAGEMENT SYSTEM

The Systems and procedures of BHEL Power Sector HSE Management System shall be implemented by the subcontractor, including:

- HSE Procedure for Register of OHS Hazards and Risks
- HSE Procedure for Register of Environmental Aspects and Impacts
- HSE Procedure for Register of Regulations
- HSE Procedure for Training and Awareness
- HSE Procedure for Emergency Preparedness and Response Plan
- HSE Procedure for Permit to Work
- HSE Inspection and Other Formats

Note:

i. BHEL reserves the right to revise/ update these systems and procedure as per requirement to address any changing HSE needs

ii. BHEL will provide hard / soft copies of applicable HSE Procedures, Work Permits, Operational Control Procedures, Inspection/ Other Formats etc. that are necessary for ensuring safe work to the successful bidder at Site. It is the responsibility of the subcontractor to ensure availability of these documents before commencing work at site.

iii. The subcontractor can get soft copies of these documents from respective Region SCT/ HSE for reference. The signed hard copies of the same shall not be required to be submitted along with tender document

iv. Subcontractor shall use the Digital (Web & App-Based) HSE management Software Systems provided by BHEL whenever provided. In case not provided, hard copy systems will continue to be used. All information technology resources (Computers, mobile phones, mobile data, internet access etc.) for the use of such systems shall be ensured by the subcontractor.

10. CLEARANCE OF MONTHLY RUNNING BILLS SUBJECT TO SAFETY COMPLIANCE

i. The monthly running Bills of the subcontractor shall be released subject to compliance to HSE requirements as per checklist in Annexure H
ii. BHEL site HSE Head and Package In-charge shall be authorized to issue the clearance
iii. Site Construction Manager of BHEL shall be the final authority on the matter.

11. HSE PERFORMANCE EVALUATION

i. Subcontractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
ii. The HSE evaluation shall be based on HSE Performance Evaluation System of BHEL covering the contractual, statutory and regulatory requirements of HSE.
iii. BHEL shall reserve the right to use these performance scores for evaluating bidder's capacity for future tenders
iv. 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, provided the execution performance is satisfactory.

12. HSE PENALTIES

i. Nonconformity of safety rules and safety appliances will be viewed seriously and BHEL has right to impose fines on the subcontractor for every instance of violation noticed.
ii. As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per following format.
iii. Following are the applicable penalties for various Safety violations:

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty (in Rs.) is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

S. No	Nature of Non - Compliance	Penalty (in INR)	Remarks
A. System Violations			
1	Working without valid Work Permit/ HIRA/ Method Statement / JSA	2000	Per case
2	Controls as per Work Permit/ HIRA/MS/JSA not ensured	2000	Per case
3	Reported Safety Violations Not Closed within Stipulated Time	1000-10000	Per case
4	Absence of required Subcontractor Officials (Site Head, HS Head) in Safety Reviews/Meetings	5000	Per case
5	Not providing required PPEs (Safety Harness, Lifeline, Safety Net, Fall arrestor, Safety Helmet, Gloves, Shoes etc.) for the work by subcontractor	2000	Per case
B. Competency/ Training/ Induction Violations			

1	Incompetent personnel deployed for specialized jobs like height work, hot work, rigging, vehicle operation etc. (without valid license/ certificate etc.)	3000	Per case
2	Work without induction training & medical check	2000	Per case
3	Height Work without Vertigo Test and height work training	2000	Per case
C. PPE Violations – Height Work			
1	Not wearing/ hooking Double Lanyard Safety Harness while working at height (> 1.2 meters) or not anchoring to lifeline	1000	Per case
2	Not Providing Lifeline for height work	3000	
3	Unsafe platforms – without Top, Mid Rails and Toe-Guards for Height Work	3000	
4	Not providing secondary means of fall protection for height work (Safety Nets, Retractable Fall Arrestors etc.)	3000	Per case
D. PPE Violations – General			
1	Not wearing safety helmet	1000	Per case
2	Wearing of helmets without chin straps	1000	Per case
3	Not Wearing safety shoes	500	Per case
4	Not wearing gloves	500	Per case
6	Not using grinding goggles/ face shield during grinding/ cutting	2000	Per case
E. Electrical Safety Violations			
1	Broken/ exposed wires/ cables	2000	Per case per day
2	Electrical plug not used for connection/ hand machines	1000	Per case per day
3	Not using proper ELCBs for electrical equipment	2000	Per case per day
4	Improper earthing of welding & Other electrical machines (Lack of double earthing, improper/ untested earth pit etc.)	2000	Per case per day
5	Not using 24 V supply for lighting in confined spaces	2000	Per case
6	Cables haphazard/ blocking way/ not organized properly	1000	Per case per day
F. Lifting & Rigging Violations			
1	Using Sling/ Chain Pulley Block and other Small T&Ps without proper, traceable Tag and Test Certificate	2000	Per T&P per day
2	Using damaged slings or not slinging properly	2000	Per T&P per day
3	Use of lifting equipment without having valid Test certificate	5000	Per equipment per seven days
4	Lifting hooks used without latches	2000	Per hook per day
5	Not effectively barricading area below lifting activity	5000	Per case
6	Using untrained/ unqualified rigger	5000	Per case
G. Housekeeping			
1	Non-removal of scrap from platforms	5000	Per Event Per location per 7 days
2	Not conducting scheduled housekeeping drives	5000	Per drive
H. Hot Work Safety Violations			
1	Gas cutting without flash back arrestor at both ends	5000	Per machine per incidence
2	Gas cutting at height without fire blanket	2000	Per event

3	Not keeping gas cylinders vertically	2000	Per event
4	Lifting cylinders without cage or rolling of cylinders	2000	Per incidence
5	Leakage in gas cylinder	2000	Per incidence
I. Vehicle Safety/ Operation			
1	Not having valid driving license for the type of vehicle/ T&P	2000	Per driver per incidence
2	Two-wheeler entry in construction area	2000	Per vehicle
3	Using Hydra for material movement at site in unsafe manner	2000	Per case
4	Using Two Hydra in Tandem for material movement without proper precautions as per OCP	2000	Per case
5	Vehicles, Hydras, Cranes, Dumpers and Earth Movers not having automatic back horns linked to gear	2000	Per Equipment per day
6	Not providing proper hard barricades around excavations/ unpermitted areas	5000	Per location per day
7	Not using guide rope while transporting material using Hydra or Cranes	2000	Per event
8	Over speeding	5000	Per case
9	Using Conventional Hydra crane	50000	Per day /crane
J. Accidents/ Incidents/ Near Misses			
1	Non-reporting of Near Miss/ Incident	20000	Per case
2	Major Accident – Worker unable to resume work within 48 hrs	100000	Per incident
3	Fatal Accident	500000	Per incident
K. Miscellaneous			
1.	Not providing the facility (drinking water, rest shed, labor colony etc. as per the specifications/ requirement)	5000	Per month per violation
2.	Not nominating the required number of workers for training as per plan	5000	Per incidence
3.	Lack of proper arrangement for disposal of sewage/ waste water/ effluents etc.	10000	Per incidence

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.):

_____
_____
_____

Penalty Amount:

1. Rate as per above chart
2. No. of Persons/ machine/ event/ labor
3. No. of times the same error is repeated: Repetition factor
4. Total Penalty= 1. X 2. X 3. =

Witnessed by:

(Sub- Subcontractor representative) (BHEL representative)

Signature _____

_____

Name _____

_____

Distribution: 1 Copy: to Sub- subcontractor Site In-charge,
1 Copy to Site Construction Manager (BHEL)
1 Copy to Site Finance

Note:

i. In case the amount of penalty imposed by BHEL's Client on BHEL for Safety violation/ incident due to or in the area of the subcontractor is more than those indicated above, same shall be imposed back-to-back on the subcontractor. However, in case such an amount is less than the specified above, penalty amount indicated above shall be imposed on the subcontractor.

ii. For same violation only one penalty (higher of the two mentioned below) shall be applicable
   a. Penalty imposed by BHEL's Customer over BHEL.
   b. Penalty as indicated in current document.

iii. For repeated violation for the same equipment/ location, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

iv. For repeated fatal incident in the same Unit incremental penalty shall be imposed: The subcontractor will pay 2 times the previously paid penalty in case there is repeated major/ fatal incident under the same subcontractor for the same package in the same unit.

v. 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.

vi. 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.

vii. The penalty amount shall be recovered by BHEL Finance department from subcontractors from the RA/Final bill.

13. PUNITIVE ACTIONS FOR "CRITICAL SAFETY VIOLATIONS":

"Critical Safety Violations" include:

i. Not wearing required PPEs when provided and not following safe work procedure

ii. Taking unnecessary risks especially in height work, hot work, radiation work, lifting activity

iii. Coming to work under influence of sedatives like alcohol, drugs etc.

iv. Coming to work without ID Card/ Gate Pass (if provided)

v. Intimidating/ threatening at work

vi. Using cell phones during height work, hot work, lifting activity, driving.

In case any worker carries out any of the critical safety violations as above, BHEL reserves the right to enforce punitive action in following manner:

First Offence:	1 Punch on Gate Pass/ Induction Card/ ID Card etc. and 1-hour HSE Training. With one day off from duty
Second Offence:	2 Punches and 2-hours HSE Training with one day off from duty

Third Offence:	3 Punches and the worker will be dismissed. Gate pass to be confiscated

In case any employee of subcontractor carries out any of the critical safety violations as above, subcontractor Site In-charge shall issue warning letter to concerned employee with copy to BHEL

Note:

i. For above violations, guilt of the worker/ employee has to be established through appropriate evidences and records maintained.

ii. If worker/ employee has not been given the required PPEs and safety equipment by the agency and/or not facilitated by the agency to follow safety rules, he/ she will not be considered liable but the agency will be penalized as per penalty provision in this document. In such cases, the subcontractor shall not pass the penalty over to the worker/ employee through wage deduction etc.

iii. These critical safety violations and their consequences shall be shared with all workers and employees during induction and other training programs/ meetings, toolbox talks etc.

iv. Gate Pass shall have provision of Tagging as indicated above

v. The appellate authority (only for final dismissal) in this case shall be the BHEL Site In-charge whose decision shall be final on the matter and binding on all parties.

14. LEGAL IMPLICATIONS

Any legal Costs incurred by BHEL, on account of accidents taking place in the activities of the subcontractor, shall be debited to the subcontractor on actual cost basis.
For any accident occurring at site to any worker/ employee of the subcontractor leading to legal implications to BHEL Employee/ Management shall be safeguarded by BHEL legal department. All legal expenses incurred by BHEL on this account shall be recovered from the subcontractor. The accident also includes fire, loss of property or life at site.

15. HSE REVIEW MEETING

i. Subcontractor Site In-charge and HSE In-charge shall attend the HSE Review Meeting as and when called by BHEL.
The indicative agenda points are given below:

a) Implementation of earlier MOM points
b) Compliance Status of HSE Observations
c) Incidents & Near Misses, their Root Causes and Actions Taken
d) HSE performance review
e) HSE inspection findings
f) HSE audit and CAPA
g) HSE training
h) Health check-up camp
i) HSE planning for the erection and commissioning and installation activities in the coming month

j) HSE reward and promotional activities

ii. MOM on the discussion along with HSE observations will be circulated to the subcontractor for action.

iii. The subcontractor shall close the observations to the satisfaction of BHEL within stipulated time frame

16. OTHER REQUIREMENTS

i. 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 and the cost shall be debited to the subcontractor with applicable overheads.

ii. 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.

iii. 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.

iv. 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.

v. 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.

vi. The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.

vii. 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.

viii. 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.

17. 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……..have gone through and understood all the HSE requirements of the contract including HSE manpower, tools & equipment, systems & procedures, and agree to fulfill the same as a minimum. Any additional resources and support required for ensuring fulfillment of HSE Objectives shall be provided by subcontractor at no extra cost.

M/s…….. agree that in case they fail to comply to the HSE requirements as stipulated in the contract, BHEL shall have the right to implement the same and the cost shall be recovered from the subcontractor with applicable overheads.

M/s…….. shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be imbibed in 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.

M/s…….. agree that the subcontractor shall seek HSE clearance as per BHEL format before each RA bill as mentioned in clause no. 9. The penalty amounts for not providing Safety manpower and various Safety violations have also been reviewed and agreed.

M/s…….. agree to share the HSE Costs (running costs) of common facilities created by BHEL on proportional to contract value basis as calculated at Site by BHEL.

Signed by authorized representative of M/s ----------

Name :

Place & Date:

SECTION B

OPERATIONAL REQUIREMENTS

1. 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 in complementary manner.

1.3. Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy wherein the relevant statutory guidelines supersedes this document, the same shall be followed.

1.4. In case there's any specific HSE requirement from BHEL's Client, not explicitly indicated in this document the same shall be required to be fulfilled as per the decision of BHEL Site construction manager.

2. SCOPE:

The document is applicable to BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations

3. OBJECTIVES AND TARGETS:

i. To achieve "Zero Incident at Site"
ii. 100% compliance to all legal/statutory requirements related to EHS.
iii. 100% Health, Safety and Environmental Induction training attendance for all workers.
iv. 100% High Risk activities to be carried out only after approved Method Statement, HIRA / Aspect-Impact / JSA / OCP and Permit to Work are implemented.
v. 100% PPEs compliance in high and medium risk activities.
vi. 100% incident reporting, recording and reviewing for corrective actions.
vii. Regular Safety Reviews to assess HSE program compliance and closure of any recognized gaps to improve safety management and incident prevention
viii. Prevent injury and ill health of all workers at site ('Workers' refers to all personnel including managerial, supervisory, professional, technical, clerical and other workers including contract laborers)
ix. Prevent pollution to environment
x. Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
xi. Ensure protection of environment of the work site.
xii. Comply at all times with the relevant statutory and contractual HSE requirements.
xiii. Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
xiv. Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.

xv. Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
xvi. Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
xvii. Establish effective communication on HSE matters with all relevant parties involved in the Project works.
xviii. Ensure that all work planning considers all persons that may be affected by the work.
xix. Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
xx. Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
xxi. Ensure continual improvements in HSE performance.
xxii. Ensure conservation of resources and reduction of wastage.
xxiii. Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
xxiv. Ensure timely implementation of correction, corrective action and preventive action. The subcontractor shall also comply with HSE Targets stipulated by BHEL from time to time.

4. BHEL HEALTH, SAFETY & ENVIRONMENT POLICY:

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, subcontractors 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.

Chairman & Managing Director/ BHEL

5. ILLUSTRATIVE RESPONSIBILITIES OF SUBCONTRACTOR EMPLOYEES

5.1 HSE - A LINE RESPONSIBILITY

i. HSE is a “Line Responsibility”.
ii. The term "Line" includes management, Executives, Supervisors, Foremen, and Workers who are part of the workforce. Line is to be fully involved in HSE Planning & Implementation with the aid and advice of HSE organization.
iii. “Line”, having control of resources and manpower is responsible for overall implementation of HSE Systems and closure of HSE observations.

5.2 SITE IN -CHARGE:

i. Shall sign Memorandum of Understanding (MoU)
ii. Shall ensure availability of all necessary resources required for implementation of HSE at Site
iii. Shall engage qualified HSE Officer(s) and supervisors (s)
iv. Shall adhere to the rules and regulations mentioned in this code, practice very strictly in area of work in consultation with concerned engineer and the safety coordinator.
v. Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
vi. Shall not engage any employee below 18 years.
vii. Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job.
viii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
ix. Shall ensure closure of all HSE non-conformities reported by BHEL or observed during internal inspection by providing appropriate resources in a timely manner.
x. Shall ensure the implementation of provisions of applicable acts and rules pertaining to HSE.
xi. Shall ensure availability of updated (Hazard Identification and Risk Assessment) Register for the area of activity
xii. Shall ensure availability of Method Statements & Job Safety Analysis for all hazardous activities
xiii. Shall ensure necessary controls to minimize risk in all applicable hazardous activities including Height Work, Hot Work, Lifting & Rigging, Confined Space, Maintenance, excavation, Radiography, Loading/ Unloading, Drilling/ Blasting etc.
xiv. Shall ensure implementation of HSE requirements mentioned in this document and as specified in the BHEL HSE management System including training, inspection, awareness, reporting etc.
xv. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
xvi. Shall ensure a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) for preventing fall from height
xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.

xviii. Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
xix. Shall ensure that Horseplay is strictly forbidden.
xx. Shall ensure that adequate illumination is arranged during night work.
xxi. Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
xxii. Shall ensure display of adequate signage/posters on HSE.
xxiii. Shall ensure that mobile phone is not used by workers while working.
xxiv. Shall ensure conductance of HSE audit, mock drill, medical camps, induction training and training on HSE at site.
xxv. Shall ensure full co-operation during HSE audits.
xxvi. Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
xxvii. Shall ensure good housekeeping.
xxviii. Shall ensure adequate valid fire extinguishers are provided at the work site.
xxix. Shall ensure availability of sufficient number of toilets (preferably bio-toilets) /restrooms and adequate drinking water at work site and labor colony.
xxx. Shall ensure adequate emergency preparedness.
xxxi. Shall be member of site HSE committee and attend all meetings of the committee
xxxii. Power source for hand lamps shall be maximum of 24 v.
xxxiii. Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available
xxxiv. To record all incidents including near miss and report to BHEL and to ensure analysis & corrective actions for the same
xxxv. Shall conduct weekly Safety Walks in the work area and record the findings.
xxxvi. Construction of Canteen at Site, Office Infrastructure: Printer, PC, Fire Extinguishers etc.
xxxvii. Shall analysis HSE Performance regularly in work area and take steps to improve the same
xxxviii. Shall ensure stoppage of work in case of unacceptable Safety hazards

5.3 HSE OFFICER:

i. Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
ii. Facilitate inclusion of safety elements into Work Method Statement and creation of Job Safety Analysis (JSA)
iii. (HSE Head) To prepare deployment plan of HSE personnel for all shifts, so as to ensure constant supervision of all areas. The plan to be submitted to BHEL
iv. Highlight the requirements of safety through Tool-box / other meetings.
v. Help concerned HOS to prepare Job Specific instructions/ JSA for critical jobs.
vi. Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
vii. Advice & co-ordinate for implementation of HSE Systems & Procedures.
viii. To stop work in case of any critical safety violation until the violation is cleared
ix. Convene HSE meeting & minute the proceeding for circulation & follow-up action.

x. Plan procurement of PPE & Safety devices and inspect their healthiness.
xi. Report to BHEL on all matters pertaining to status of safety and promotional program at site level.
xii. Facilitate administration of First Aid
xiii. Facilitate screening of workmen and safety induction.
xiv. Conduct fire Drill and facilitate emergency preparedness
xv. Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
xvi. Apprise BHEL on safety related problems.
xvii. Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
xviii. 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.
xix. To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
xx. Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
xxi. Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters.

5.4 HSE SUPERVISOR:

i. All requirements as per 5.1
ii. To monitor allotted area for Safety violations, take required action and inform the concerned Safety Supervisor / Officer
iii. To assist HSE Officer

5.5 PACKAGE IN-CHARGES, ENGINEERS & ALL EMPLOYEES:

i. To be aware of, get involved in and ensure implementation of all HSE related Systems and Procedures including but not limited to:
    a. BHEL HSE Management System including HSE Procedures and OCPs, HIRA, JSA etc.
    b. Work Permit System
    c. Emergency Preparedness Response Plans
    d. Contractual HSE requirements
    e. Legal Requirements
    f. Penalty System
    g. Training requirements
ii. To ensure that the persons engaged in respective area follow the safety rules like using appropriate PPEs.
iii. To develop Method Statements and ensure availability of Job Safety Analysis for all activities in scope
iv. To ensure that the reported HSE non-conformities in the work area are resolved immediately before resuming work
v. To record all incidents including near miss and report to BHEL.

vi. To adopt safe working practices at all times and act as role model for Safety
vii. To take immediate corrective action actions in case any non-conformity is observed on product / process / system with respect to Occupational Health, Safety and Environment.
viii. In case any particular activity / work has extremely high consequential risk or high environmental impact, same shall be brought to the notice of BHEL Package In-charge before starting the work.
ix. To interfere/ stop work as & when identified unsafe.
x. To maintain & promote improved level of house-keeping all the time at site.
xi. To support/co-operate with audit team members as & when safety audits are carried out.
xii. To involve in investigation, if any incident occurs in his work area.
xiii. To participate in safety promotional programs
xiv. To attend the safety committee meeting, if member/invitee
xv. To ensure that only fit T&Ps and qualified persons are engaged for all activities.
xvi. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
xviii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent authorities.

6. HSE PLANNING BY SUBCONTRACTOR:

6.1 HAZARD ANALYSIS & RISK ASSESSMENT (HIRA), METHOD STATEMENT (MS) & JOB SAFETY ANALYSIS (JSA):

i. Subcontractor shall identify all OHS Hazards and Risks applicable to all activities in scope and plan & implement the required control measures. HIRA Register shall be maintained.
ii. Subcontractor shall develop Method Statements & Job Safety Analysis documents for all hazardous activities in scope and ensure the required control measures. Job Safety Analysis is to be attached along with any Work Permit request

6.2 REGISTER OF REGULATIONS:

Subcontractor shall prepare a register of applicable rules and regulations in the scope and plan to ensure compliance.

HIRA Register, Method Statements, Job Safety Analysis and Register of Regulations are dynamic documents and shall be revised (as applicable):

i. At fixed frequency of 3 months
ii. Addition/ deletion/ modification of a process/ activity
iii. After an accident/ incident
iv. After any change in applicable rules/ regulations/ laws.

6.3 MONTHLY HSE PLAN COVERING THE FOLLOWING AS A MINIMUM SHALL BE PREPARED AND SUBMITTED TO BHEL FOR APPROVAL:

i. HSE Trainings covering all activities/ hazards/ workers

ii. HSE Inspection Plan covering all areas/ activities/ equipment/ hazards

iii. HSE Activities: Safety walks, Awards, housekeeping, reviews etc.

Note: Online/ App-based system shall be used for HSE Planning and Implementation/ Update whenever provided by BHEL otherwise Hard-copy based system shall continue

6.4 MONTHLY HSE PLANNING & REVIEW OF HSE ACTIVITIES ALONG WITH BHEL:

Monthly planning and review of HSE activities shall be carried out by subcontractor as per provided **format** jointly along with BHEL

7. MOBILIZATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR:

i. 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.

ii. 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. Inspection by Third Party competent person shall be arranged:
   a. Before first time use at site
   b. After carrying out any modification
   c. After repairs subsequent to involvement in any accident/ incident

iii. As a further 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 comply with legislative and owner requirement, inspection as per provided format shall be arranged by in-house expert / competent authority (preferable) for acceptance. The equipment considered for this purpose shall include all those in the T&P list in the tender document.

8. MOBILIZATION OF MANPOWER BY SUBCONTRACTOR:

i. As a measure to ensure that manpower being mobilized to the construction site is fit and competent for safe working, screening arrangement shall be made by the sub-subcontractor to ensure competency and fitness through following measures:

a) **Medical Checkup:** Examination of medical fitness shall be conducted through qualified medical professional for all workers to be deployed as per provided **format**. For height workers, vertigo (height phobia) test to be carried out as qualification criteria as per Annexure K and recorded in provided **format**.

b) **Induction Training**: Induction training of all workers to be ensured as per **provided procedure and format**. Training evaluation to be carried out and training to be repeated if not passed

c) Only on successfully meeting above criteria, permanent gate passes to be issued

ii. The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.

iii. 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.

iv. 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.

v. Appropriate accommodation to be arranged for all workmen in hygienic condition.

vi. Cost of contractual, statutory and regulatory requirements like Training, medical checks, PPEs etc. shall not be transferred to the workers and such activities shall be considered as part of the job.

9. Provision of Personal Protective Equipment (PPEs):

i. Personnel Protective Equipment (PPEs), shall be provided by the subcontractor to all workers as per requirement of the job.

ii. The choice of PPEs to ensure multiple (at least more than 1) means of protection against any hazard. All applicable safety precautions for a job shall be ensured notwithstanding the duration or perceived importance of the task.

iii. The applicability of PPEs shall be as per the concept of Hierarchy of controls, i.e.:

iv. Elimination->Substitution->EngineeringControls->AdministrativeControls-PPEs

v. Relying solely on PPEs without ensuring necessary controls to be strictly avoided.

vi. The following matrix recommends usage of minimum PPEs against the respective job.

Activity	Type of Protection						Remarks, if any
	Hand	Eye	Ear	Body	Respiratory	Others	
Gas Welding & Cutting	LG	WG	-	LA	*SCBA/ OLBA	-	* for confined space
Electric Arc Welding	LG	HMWS	-	LA	*SCBA/ OLBA	-	* for confined space
Rigging	CG	SG	-				--
Working at Height	-	SG	-	DLFBH	-	*FAS	* for vertical columns
Grinding & Chipping	CG	FS / SG	-	LA	-	-	--
Working in High Noise	-	-	EP / EM	-	-	-	--
Handling of Cement Concrete	RG	SG	-	-	DM	-	

Blasting	CG	SG	EP*	-	-	-	* at noise area
Excavation	CG	SG	-	-	DM	-	*Gum boot in place of Safety shoe for foot
Chemical Handling	PVCG	CSG	-	PVCA	-	-	*Full body rubber suit with hood
Electrical and C&I	ERG*	SG	-	-	-	-	*For high voltages
Sand/shot blasting	CG	-	EP/ EM	CA	SAMH	-	

ABBREVIATIONS: FS: Face Shield, CSG: Chemical splash goggles, HMWS: Helmet mounted welder's shield, GB: gum boot, DLFBH: Double lanyard full body harness, SG: Safety goggles, DM: Dust mask, SAMH L Supplied air mask/hood, EP/EM: Ear plug/Ear Muff, CG: Cotton hand gloves, LG: Leather hand gloves, LA: Leather apron, RG: Rubber gloves, PVCG: PVC Gloves, PVCA: PVC Apron, SCBA: Self-contained breathing apparatus, WG: Welding goggles, ERG: Electrical Rubber Gloves. OLBA: Online breathing apparatus

The list is not exhaustive. Additional PPEs to ensure Safe Work may need to be deployed as per the requirement of the task at no additional cost.

vii. The PPEs shall conform to the relevant standards as below (illustrative list) and bear ISI mark.

RELEVANT IS-CODES FOR PERSONAL PROTECTION

PPEs	IS Codes
Industrial Safety Helmets.	IS: 2925 – 1984
Rubber gloves for electrical purposes.	IS: 4770 – 1968
Industrial Safety Gloves (Leather &Cotton Gloves).	IS: 6994 – 1973 (Part-I)
Leather safety boots and shoes.	IS: 1989 – 1986 (Part-I-II)
Industrial and Safety rubber knee boots.	IS: 5557 – 1969
Code of practice for selections care and repair of Safety footwear.	IS: 6519 – 1971
Leather Safety footwear having direct molding sole.	IS: 11226 – 1985
Eye protectors.	IS: 5983 – 1978
Ear protectors.	IS: 9167 – 1979
Eye & Face protection during welding	IS: 1179-1967
Industrial Safety Belts and Harness	IS: 3521 – 1983
Guide for selection of industrial Safety equipment for body protection	IS:8519 -1977
Respiratory Protective Devices	IS:9473-2002,14166-1994,14746-1999

viii. 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

ix. All the personnel and visitors shall mandatorily use safety helmet (with company logo), safety shoe and reflective vests, in addition to any other PPEs as deemed appropriate for the area of work/ visit.

x. Following Color scheme for Helmets shall be followed:
   a. Workmen: Yellow
   b. Safety staff: Green or white with green band
   c. Electrician: Red
   d. Others including visitors: White
   e. For height workers, special marking on helmets besides indication on Gate Pass/ ID Card

xi. The subcontractor shall maintain register for issue and receipt of PPEs.

xii. All the PPEs shall be checked for quality before issue and the same shall be periodically re-checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be replaced.

xiii. The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.

xiv. The body harnesses shall be serial numbered.

10. ARRANGEMENT OF INFRASTRUCTURE:

10.1 DRINKING WATER:

i. Drinking water shall be provided and maintained at suitable places at different elevations such that minimum quantity of 5 liters is available for each worker during the day.

ii. Drinking water tank shall be so installed so as to be available within 200 meters of each working area

iii. Container should be labeled as “Drinking Water” in languages understood by the workers

iv. Cleaning of the container shall be ensured at least once in a week. Mild cleaning detergents as used for cleaning vessels shall be applied and scrubbers (3M or equivalent) shall be used for removing scales and deposits on the inside surface. The tank shall be thoroughly cleaned with potable water only before it is refilled (also applicable to labor colony).

v. Suitability of water source for drinking to be tested as per IS10500 at least once in six months.

10.2 WASHING FACILITIES:

i. In every workplace, adequate and suitable facilities for washing shall be provided and maintained.

ii. 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.

iii. Water suitable for washing and not for drinking shall be clearly indicated as “Not for Drinking” in language understood by workers.

iv. 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.

10.3 LATRINES AND URINALS:

i. Latrines and urinals shall be provided in every work place as indicated in Section A
ii. Urinals shall also be provided at different elevations.
iii. They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
iv. Separate facilities shall be provided for the use of male and female worker if any.

10.4 PROVISION OF REST SHEDS FOR WORKERS DURING REST PERIOD:

Proper Rest Shed (s) with shelter shall be provided for rest during break so as to accommodate all workers as indicated in Section A

10.5 MEDICAL FACILITIES:

10.5.1 GENERAL

i. Provision of Medical Center, Ambulance etc. shall be as per Section A of this document
ii. Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste – Management and Handling Rules, 1998)
iii. Every injury shall be treated, recorded and reported.
iv. All First Aid injuries shall be recorded as per provided Format
v. List of qualified first aiders and their contact numbers to be displayed at conspicuous places.

10.5.2 FIRST AIDER/ FIRST AID BOX

i. The first aider along with facilities should be available at a point nearest to the work location wherein majority of the workers are working.
ii. 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.
iii. 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.
iv. 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.
v. The first aid box shall be distinctly marked with a Green Cross on white background.
vi. Details of contents of first aid box is given in Annexure J
vii. A slip of contents shall be pasted on the First Aid Box with following details
viii. Monthly inspection of First Aid Box shall be carried out by the owner as per provided format
ix. The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

10.5.3 HEALTH CHECK UP

The persons engaged at the site shall undergo health check-up as per provided format before induction. In addition, the persons engaged in the following works shall undergo health check-up at least once in a year:

i. Height workers
ii. Drivers/crane operators/riggers
iii. Confined space workers
iv. Shot/sand blaster
v. Welding and NDE personnel

10.5.4 HEIGHT PHOBIA/ VERTIGO TEST:

i. The persons engaged in working at heights (above 2 meters) to be assessed for Vertigo and associated conditions and recorded as per provided format. Suggested Vertigo Test Procedure is given in Annexure K
ii. Such workers are to be allowed only on successful completion of test, otherwise shall be allocated ground-based jobs.
iii. IDs / Height passes shall be issued to such workers, besides special markings on helmets for easy identification.

10.5.5 PROVISION OF CANTEEN FACILITY:

i. Canteen facilities shall be provided for the workmen of the project inside the project site where worker strength is 250 or more.
ii. Proper cleaning and hygienic condition shall be maintained.
iii. Proper care should be taken to prevent biological contamination.
iv. Adequate drinking water should be available at canteen.
v. Fire extinguisher shall be provided inside canteen.
vi. Regular health check-up and medication to the canteen workers shall be ensured as per applicable regulations.
vii. Canteen waste to be disposed of in hygienic manner

10.6 PROVISION OF ACCOMMODATION/LABOR COLONY FOR WORKFORCE:

i. Proper accommodation for workforce to be provided in line with minimum requirements indicated in Section A
ii. Labor colony shall be inspected each week by HSE Officer and report submitted to BHEL as per provided format

10.7 PEST CONTROL:

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labor colony and stores.

10.8 SCRAPYARD:

i. In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
ii. Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

10.9 ILLUMINATION:

i. 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.
ii. Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
iii. Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
iv. Emergency lighting provision for night work shall be made to minimize danger in case of main supply failure.
v. Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II).

SUITABLE ILLUMINATION LEVELS FOR VARIOUS AREAS SHALL BE DECIDED BASED ON BROAD GUIDELINES INDICATED BELOW:

S. No.	Location	Lux Level (lumens/sqm)
A.	**Construction Site**	
1	Outdoor areas like store yards, entrance and exit roads	20
2	Platforms	50
3	Entrances, corridors and stairs	100
4	General illumination of work area	150
5	Rough work like fabrication, assembly of major items	150
6	Medium work like assembly of small machined parts	300
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

vi. Illuminations shall be inspected on weekly basis as per provided **format** using a calibrated lux meter.

11. HSE TRAINING & AWARENESS:

11.1 TRAINING PLAN:

i. All training programs to be carried out in a planned manner. Monthly/ Annual Training Calendar to be submitted to BHEL for approval and shall cover HSE Training requirements of all activities, workers, hazards applicable to the area(s) of work.
ii. Subcontractor shall nominate workers as per the schedule of specific training plan, failing which, penalty shall be imposed.
iii. Training records of all workers along with attendance, signatures, faculty details etc. shall be maintained in soft/ hard copy as per provided **formats**.
iv. Each labor should undergo at least 0.5% of total man-hours worked in HSE training.

11.2 HSE INDUCTION TRAINING

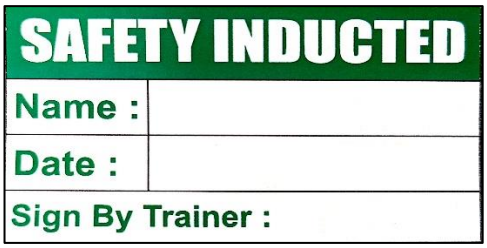
i. All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.
ii. The induction training shall be imparted through audio-visual medium (Classroom specialized training), and shall be minimum of 1 Complete Day.
iii. Evaluation to be carried out after training and training shall be repeated in case of failure.
iv. Safety Induction Card shall be printed by Subcontractor and provided to all trained workers. A Safety induction book shall also be printed and issued to each worker after induction training (Format for the same may be provided by BHEL).
v. Induction training subjects shall include but not limited to:

   a. Briefing of the Project details.
   b. Safety objectives and targets.
   c. Site HSE rules.
   d. Critical Safety Violations and consequences
   e. Site HSE hazards and aspects.
   f. First aid facility.
   g. Emergency Contact No.
   h. Incident & Near Miss reporting.
   i. Fire prevention and emergency response.
   j. Rules to be followed in the labor colony (if applicable)
   k. Accident case studies

vi. General:

   a. 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.)
   b. They must arrive fully dressed in safety wear & gear to attend the induction.
   c. Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.

d. On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form to declare that he had understood the content and shall abide to follow and comply with safe work practices.
e. They may only then be qualified to be issued with a personal I.D. card, for access to the work site subject to clearing the medical fitness test.



ABOVE STICKER SHALL BE PASTED ON HELMET OF WORKERS AFTER SAFETY INDUCTION TRAINING

11.3 JOB-SPECIFIC SKILL BASED HSE TRAINING

The contracting agency shall also impart job specific skill-based safety training to all its employees (Minimum one day) on various related safety topics using internal/external safety professionals/consultants as per the matrix given below. Record of such trainings and attendance particulars shall be maintained in a register for ready reference to statutory authorities/engineer-in charge as per provided format.

TRAINING MATRIX

Name of topic	Executives	Supervisors	Skilled Workmen	Other Workers
Safety Induction	Y	Y	Y	Y
Accident_ Causes, factors, cost	Y	Y	Y	-
Industrial hazards & Accident Prevention	Y	Y	Y	-
Investigating, reporting, records	Y	Y	-	-
Personal Protective Equipment	-	Y	Y	Y
Construction Safety & Role of Supervisory personnel	-	Y	-	-
Permit to Work (PTW)	-	Y	Y	y
Statutory Provisions (BOCW Act/Rules, Factories Act 1948 etc.)	Y	Y	y	y
Material handling	-	y	Y	Y
Emergency Management	Y	Y	Y	-
Electrical Safety	-	Y	Y	-
Fire safety	Y	Y	Y	Y
First Aid & CPR (cardio pulmonary resuscitation)	-	Y	Y	Y (Selected)
Safety in Welding & Cutting	-	-	Y	-
Safety Audit	Y	Y	-	-
Safety in Lifting Tools & Tackles	-	Y	Y	y

Safety in Working at height	-	Y	Y	Y
Safety in Confined space work	-	Y	Y	Y
Defensive Driving	-	Y*	Y*	Y*

*for construction vehicle operators, helpers & crane operators

Y=YES

Note:

i. Subcontractor shall prepare a training plan/ matrix covering all hazards and implement the same after approval of BHEL.
ii. It is to be ensured that every worker undergoes Job-Specific training once every 3 months.
iii. Records of training programmes along with attendance shall be maintained by the subcontractor
iv. Each worker to be issued a Card indicating the types of trainings undergone.

11.4 HSE TOOL-BOX TALK:

i. HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work and shall be randomly attended by subcontractor engineers/ officials. The agenda shall consist of the following:

   a. Details of the job being intended for immediate execution.
   b. The relevant hazards and risks involved in executing the job and their control and mitigating measures.
   c. Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
   d. Recent non-compliances observed.
   e. Appreciation of good work done by any person.
   f. Any doubt clearing session at the end.

ii. Tool box talk to be conducted before start of work in every shift.
iii. During toolbox talk, visual check-up of workers regarding health, any signs of fatigue, intoxication etc. shall be conducted and any suspected workers to be acted upon.
iv. Record of Tool box talk shall be maintained as per provided **format**

11.5 TRAINING ON HEIGHT WORK:

i. Training on height work shall be imparted to all workers working at height by in-house/external faculty at least once every 3 months.
ii. For Height Workers Separate pass shall be provided by the subcontractor.
iii. The training shall be of minimum 2-hour duration, through audio-visual medium and followed by evaluation. In case of poor scoring, training shall be repeated.
iv. The training shall include following topics:

   a. Proper use of PPEs – safety harness, lanyard, fall arrester, retractable fall arrester, life line, safety nets etc.
   b. Provision of secondary means of fall protection

c. Safe climbing through monkey ladders.
d. Inspection of PPEs.
e. Medical fitness requirements.
f. Mock drill on rescue at height.
g. Dos & Don'ts during height work.
h. Accident case Studies

11.6 Re-Induction Training

The induction training shall be repeated for every worker after at least 1 year and shall be a pre-requisite for renewal of Gate Pass/ ID card.

11.7 Penalty Training

The personnel involved in Safety Violations/ Incidents shall mandatorily undertake penalty training pertaining to the violation/ incident. Penalty training shall be at least half-day duration.

11.8 HSE Promotion-Signage, Posters, Competition, Awards etc.:

i. HSE Displays shall be installed as indicated in Section A
ii. Contracting agencies shall arrange for display of safety hoardings depicting suitable safety cartoons/messages/ cautionary notices at appropriate places of project site to remind the workers to perform their duties safely.
iii. Apart from safety hoardings, each agency should maintain a safety bulletin board at all their work locations. Such safety bulletin boards should depict the activities being planned for the day, good practices, permit details etc.
iv. Safety suggestion boxes shall be kept at each subcontractor's office at site for obtaining safety suggestions from the workers. Best suggestions should be implemented and may be rewarded suitably to encourage the workers for safety.
v. Safety awareness campaigns, competitions, plays, movie shows, songs etc. to be organized for workers at Site and Labor colony from time to time to enhance Safety Awareness

11.9 HSE Rewards & Incentive Scheme

Subcontractor shall implement a reward & incentive scheme for workers & supervisors displaying adherence to safety principles. Such workers shall be felicitated in a monthly function, attended by Subcontractor top management and BHEL representatives. Suitable gift shall be given to such workers for encouragement.

11.10 HSE Awareness Program for Officials:

Subcontractor shall arrange monthly HSE awareness program on different topics including medical awareness for all engineers/ supervisors / officials working at site. This program can be part of progress/ safety review meetings.

12. HSE COMMUNICATION AND PARTICIPATION:

12.1 HSE INCIDENT REPORTING, INVESTIGATION & CORRECTIVE ACTION:

i. All incidents (near misses, property damage, first-aid cases, minor, major and fatal incidents) shall be reported to BHEL as they happen immediately through SMS and Hard/Soft copy as per provided format

ii. All incidents including near miss, minor, major and fatal incidents shall be recorded

iii. All incidents shall be investigated for Root Causes and corrective actions ensured to prevent recurrence shall be implemented.

iv. Work shall be put on hold in the area till corrective actions are verified by BHEL

v. The Root Cause Analyses and Corrective actions taken shall be recorded

12.2 HSE EVENT REPORTING:

i. 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

ii. Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

12.3 MONTHLY HSE REPORTING:

i. All routine and non-routine HSE activities shall be reported to BHEL on monthly basis by the subcontractor as per provided format. The reporting medium can be hard/soft as per BHEL requirement.

ii. The period of reporting shall be 25th of the preceding month to 24th of the present month and shall be submitted by the end of the calendar month.

iii. Report shall include good quality images of HSE Activities

12.4 DAILY HSE ACTIVITY REPORTING:

Daily HSE activities shall be reported by subcontractor to BHEL as per provided format

12.5 HSE SUGGESTIONS:

All workers and employees shall be encouraged to provide suggestions for improvement in Health, Safety & Environment performance at site. The suggestions shall be recorded in a “Suggestions Register” as per provided format. Suggestions found suitable for implementation shall be implemented and recognition / reward to be given to the submitter.

Suggestion Register to be placed at Site and Labor Colony and shall be reviewed on periodic basis

12.6 CLIENT COMMUNICATION:

All HSE related communication from BHEL, customer / external statutory and regulatory agencies to be handled on priority. Same to be recorded and issues to be resolved in expeditious manner

13. SAFETY DURING WORK EXECUTION:

Safety during work execution shall be ensured by following appropriate Safety Rules, providing adequate resources, deploying competent and trained manpower, regular training & inspection and non-conformity resolution. Main aspects are indicated as under:

13.1 OPERATIONAL CONTROL PROCEDURES:

In order to reduce the risk associated with hazardous activities, applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions, outcomes of Hazard Analysis & other requirements. This will be done as part of normal scope of work. Illustrative list of reference OCPs is given below.

TABLE 13.1 ILLUSTRATIVE LIST OF REFERENCE OCPS

No.	Topic	No.	Topic	No.	Topic
0	General Safety	**22**	Steam blowing	**44**	Material preservation
1	Handling of chemicals	**23**	Working in confined area	**45**	Electro-resistance heating
2	Electrical safety	**24**	Operation of passenger lift, material hoists & cages	**46**	Blasting
3	Energy conservation	**25**	Vehicle/ Crane maintenance	**47**	Transformer charging
4	Welding and gas cutting operation	**26**	Radiography	**48**	Handling of battery system
5	Fire safety	**27**	Waste disposal	**49**	DG set
6	Use of hand tools	**28**	Handling & storage of mineral wool	**50**	Sanitary maintenance
7	First aid	**29**	Working at night	**51**	Piling rig operation
8	Food safety at canteen	**30**	Computer operation	**52**	Passivation
9	Use of cranes	**31**	Storage in open yard	**53**	EDTA Cleaning
10	Storage and handling of gas cylinders	**32**	Drilling, reaming and grinding(machining)	**54**	Chemical cleaning of Pre boiler system
11	Manual arc welding	**33**	Stress relieving	**55**	Boiler Light up
12	Use of helmets	**34**	Hydraulic test	**56**	Rolling and Synchronization
13	Good house keeping	**35**	Trial run of rotary equipment	**57**	Loading of Unit

14	Safe excavation	**36**	Batching	**58**	Air compressor
15	Working at height	**37**	Cable laying/tray work	**59**	Hydra Operation
16	Filling of hydrogen in cylinder	**38**	Spray insulation	**60**	Duct Pre-assembly
17	Illumination	**39**	Compressor operation	**61**	Resumption of construction activities after lockdown and prevention of coronavirus infection during site operations
18	Handling and erection of heavy metals	**40**	Gas distribution test		
19	Acid cleaning	**41**	Cleaning of Hot well / Deaerator		
20	Oil flushing	**42**	Electrical maintenance	**61A**	Prevention of Covid-19 infection in labour colony
21	Alkali boil out	**43**	O&M of control of AC plant & system	**62**	Truss/ Structure fit-up and alignment

a. The reference OCPs shall be suitably modified by subcontractor as per specific requirements to control the hazards.

b. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will prepare and follow those as well.

13.2 Work Permit System:

i. The following activities shall be carried out by the subcontractor strictly after obtaining Permit to Work from BHEL
   a) Height working
   b) Hot working
   c) Confined space Work
   d) Excavation more than 2-meter depth
   e) Radiography
   f) Heavy / Complex / Critical Lifting Activity
   g) Night / Holiday Work
   h) Material Loading / Unloading
   i) Grating, Safety Net, Safety Facility Removal
   j) Live Electrical Maintenance etc. - Lockout / Tagout
   k) Beam / truss/ duct/ structure alignment

ii. The Work Permit Formats shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability

iii. The above list is not exhaustive. BHEL reserves right to introduce additional Permits or modify requirements for usage of existing Permits. The conditions for using the Permit are specified in the Format (General Requirements).

iv. Where customer is having separate Work Permit System the same shall be followed in conjunction / merged to ensure all activities and checks are covered in all systems.

v. Details of working Group to be attached along with work permit request.

vi. All the Permits along with JSA/HIRA must be initiated by Agency Execution Team
vii. Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
viii. All Permit signatories (including subcontractor's package in-charge and HSE Officer) shall physically visit the work area and check that all the safety control measures necessary for the activity are in place. Only then the permit shall be issued.
ix. Signatory shall physically visit the area of work and ensure all required safeguards before signing the Permit
x. Signatory shall periodically visit the area to confirm the availability of required safeguards throughout the currency of the permit
xi. In case any Permit requirement is not available, work will be stopped till it is made available
xii. Permit holder shall implement and maintain all control measures during the period of permit. The permit will be closed after completion of the work.
xiii. Online Work Permit System shall be used whenever provided by BHEL, otherwise hard copy shall be used

13.3 Activity-Specific Precautions/ Controls

Detailed HSE precautions for various activities undertaken at Site by the subcontractors are specified in **Annexure I**. Same are to be ensured by the Sub-subcontractor while carrying out respective activities at Site

Index of **Annexure I** is given as under

SN	Description	Page No.
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3.1	Excavation	8
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3.6	Concrete Mixers	11
4.	Welding & Gas Cutting Safety (Hot Work)	11
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5.1	Cranes & Hoisting Equipment	15
6.	Demolition Work	20
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10.	Use of Hand Tools and Power-Operated Tools	25
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14. ENVIRONMENTAL CONTROL & SOCIAL RESPONSIBILITY

i. 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. Banned substances like asbestos and 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.

ii. 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).

iii. 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

iv. All subcontractors shall be responsible for the cleanliness of their own areas

v. Regular dust suppression using sprinklers shall be carried out in respective area

vi. 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.

vii. 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, enhancing good relation with local populace etc.

viii. 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.

15. HOUSEKEEPING

i. Keeping the work area and access roads 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 have to be done by subcontractor within quoted rate, on daily basis.

ii. 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 subcontractor's bill. Such decisions of BHEL shall be binding on the subcontractor

iii. Dedicated Housekeeping gangs shall be deployed, who shall be provided all required PPEs and safety training

iv. Mass housekeeping shall be carried out for half a day in a week

v. Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.

vi. All surplus earth and debris are removed/disposed off from the working areas to identified locations.

vii. Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.

viii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations.

ix. 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 locations.

x. Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.

xi. Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.

xii. Labor 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.

xiii. Fabricated steel structures, pipes & piping materials shall be stacked properly.

xiv. 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.

xv. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

16. WASTE MANAGEMENT

i. 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.

ii. Details of E-Waste, Hazardous Waste, biomedical waste etc. and their disposal plan, shall be submitted to BHEL every 6 months as per provided **formats**.

16.1 Bins At Work Place

i. Sufficient rubbish bins shall be provided close to workplaces.
ii. Bins should be painted yellow and numbered.
iii. Sufficient nos. of drip trays shall be provided to collect oil and grease.
iv. Sufficient qty. of broomsticks with handle shall be provided.
v. Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

16.2 Storage And Collection

i. Different types of rubbish/waste should be collected and stored separately.
ii. Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
iii. Rubbish should not be left or allowed to accumulate on construction and other work places.
iv. Do not burn construction rubbish near working site.

16.3 Segregation

i. Earmark the scrap area for different types of waste.
ii. Store wastes away from building.
iii. Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
iv. Clinical and first aid waste stored and incinerated separately.

16.4 Disposal

i. Sufficient containers and scrap disposal area should be allocated.
ii. All scrap bin and containers should be conveniently located.
iii. Provide self-closing containers for flammable/spontaneously combustible material.
iv. Keep drainage channels free from choking.
v. Make schedule for collection and disposal of waste.

16.5 Warning And Signs

i. Appropriate sign to be displayed at scrap storage area
ii. No toxic, corrosive or flammable substance to be discarded into public sewage system.
iii. Waste disposal shall be in accordance with best practice.
iv. Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

17. Traffic Management System

17.1 Safe Workplace Transport System

i. 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.

ii. 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.

iii. For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.

iv. Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.

v. Speed limits shall be clearly displayed for each kind of vehicle.

vi. Speed ramps preceded by a warning signs or marker are necessary.

vii. 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.

viii. Safest route shall be provided between places where vehicles have to call or deliver.

ix. Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse

x. Safe areas shall be provided for loading and unloading.

xi. Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.

xii. Ensure road crossings are minimum and clearly signed.

xiii. Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.

xiv. Set sensible speed limits which are clearly sign posted.

xv. Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.

xvi. Forklift trucks shall not pass over road hump unless of a type capable of doing so.

xvii. Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.

xviii. 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.

17.2 Traffic Route For Pedestrians

i. Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.

ii. 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.

iii. Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.

iv. Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.

v. Provide high visibility clothing for people permitted in delivery area.

17.3 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:

i. A high level of stability.
ii. A safe means of access/egress.
iii. Suitable and effective service and parking brakes.
iv. Windscreens with wipers and external mirrors giving optimum all round visibility.
v. Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
vi. Provision of seat belts.
vii. Guards on dangerous parts.
viii. Driver protection - to prevent injury from overturning and from falling objects/materials.
ix. Driver protection from adverse weather.
x. No vehicle shall be parked below HT/LT power lines.
xi. Valid Pollution Under Control certification for all vehicles
xii. Wheel stopper shall be use during the parking of vehicle
xiii. Helper to be deployed in each vehicle as per site requirement.

17.4 DAILY CHECK BY DRIVER

1. There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.

Brakes	Mirrors	Warning signals
Tires	Windscreen waters	Specific safety systems i.e. controls & interlocks
Steering	Wipers	

2. Management should ensure that drivers carry out these checks.

17.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

i. 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.

ii. 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.

iii. All overhangs shall be made clearly visible and restricted to acceptable limits

iv. Load shall be checked before moving off and after traveling a suitable distance.

v. 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.

vi. Warning signs shall be displayed during transportation of material.
vii. All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.
viii. Wheel stopper shall be use during the parking of vehicle
ix. Helper to be deployed in each vehicle as per site requirement.

17.6 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.

18. EMERGENCY PREPAREDNESS AND RESPONSE

i. Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by BHEL
ii. Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
iii. 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.
iv. Assembly point shall be earmarked and access to the same from different location shall be shown
v. Fire exit shall be identified and pathway shall be clear for emergency escape.
vi. Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
vii. 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.
viii. First aid center shall be developed at site with trained medical personnel and ambulance
ix. Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
x. Tie up with fire brigade shall be done in case customer is not having fire station.
xi. Tie up with hospital shall be done in case customer is not having hospital.
xii. Disaster Management group shall be formed at site
xiii. Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL HSE Officer as per prescribed BHEL formats
xiv. Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

19. HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSE 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 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.

Online/ App-based HSE Inspection system shall be used for inspection whenever provided by BHEL otherwise Hard-copy based system shall continue

	OK	NOT OK
Contractor Name:		
Equipment Identification No :		
Inspection Date :		
Next Inspection Date :		
Inspected By :		

Every Inspected Equipment shall display above sticker

19.1 INSPECTION PLAN

Subcontractor shall prepare an inspection plan covering all areas/ activities/ equipment/ hazards and implement the same after getting approval of BHEL. Responsibility to ensure coverage of all areas/ activities rests with the subcontractor.

All Inspections shall be witnessed by BHEL – only then they shall be considered as valid

19.2 INSPECTION REPORTS

Monthly inspection reports as per plan shall be submitted to BHEL HSE Head

19.3 NON-CONFORMANCES

Any non-conformances identified during inspection observed shall be addressed on priority.

The responsibility of resolution shall rest with the Subcontractor Site In-charge

In case immediate closure of non-conformities is not possible:

a. work to be halted in the area
b. non-conformance to be generated and submitted to responsible person and BHEL
c. non-conformance to be resolved through responsible agency / person

Only after closure of non-conformances, work to be allowed to resume

19.4 DAILY HSE CHECKS

Both the Site Supervisors and HSE 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:

i. Personal Safety wears & gear compliance.
ii. Complying with site safety rules and permit-to-work (PTW).
iii. Positions and postures of workers.
iv. 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.

19.5 Indicative List of Inspections And Periodicities

Indicative list & periodicity of Inspections is given as under. It is the responsibility of the subcontractor to develop an inspection plan covering all areas & activities in the scope.

SL. No.	Format Name	Frequency of check (if applicable)
01	Inspection of First Aid Box	Weekly
02	Inspection of PPE	Weekly
03	Inspection of T&Ps	Monthly
04	Inspection of Cranes	Monthly
05	Inspection of Winches	Monthly
06	Inspection on Height Working	Weekly
07	Inspection on Welding & Gas Cutting	Monthly
08	Inspection on Electrical Installation	Monthly
09	Inspection on Elevator	Weekly
10	Inspection of Excavation	Weekly
11	Inspection of Labor Colony	Monthly
12	Inspection of Illumination Levels	Weekly

The checklists shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability before start of work

19.5.1 Inspection Of PPE

i. PPEs shall be inspected by HSE officer at random once in a week as per provided **format** for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
ii. The applicable PPEs for carrying out particular activities are listed below.

19.5.2 Inspection Of Tools & Plants (T&Ps)

i. A master list of T&Ps shall be maintained by each subcontractor in provided **format**.
ii. All T&Ps being used at site shall be inspected by HSE officer once in a month as per provided **format** for its healthiness and maintenance.
iii. 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.

iv. BHEL shall be given advance intimation of Third-Party Inspection. BHEL shall associate with Inspection as per discretion.
v. The validity of T&P shall be monitored as per provided **format**

19.5.3 Inspection Of Cranes And Winches

i. 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.
ii. Cranes and Winches shall be inspected by HSE officer once in a month as per provided **format** for healthiness, maintenance and validity of third-party inspection.
iii. The date of third-party inspection and next due date shall be painted on cranes and winches.
iv. The operators/drivers shall be authorized by sub-subcontractor based on their competency and experience and shall carry the I-card.
v. 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.

19.5.4 Inspection Of Height Working

i. Any activity carried out at more than 2 m height is classified as height work.
ii. Inspection of height working shall be conducted daily by Supervisors before start of work to ensure safe working condition including provision of
   a. Fall arrestor
   b. Lifelines – connected to rigid & independent structure
   c. Safety nets deployed below all height work activities
   d. Fencing and barricading
   e. Warning signage
   f. Covering of opening
   g. Proper scaffolding with access and egress.
   h. Illumination
iii. For full duration of height work, constant supervision to be maintained by dedicated HSE personnel
iv. Inspection on height working shall be conducted once in a week by HSE officer as per provided **format**.
v. Medical fitness of height worker shall be ensured.
vi. Height working shall not be allowed during adverse weather.

19.5.5 Inspection Of Welding And Gas Cutting Operation

i. Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
ii. Gas cylinders shall be kept upright.
iii. Use of Flash back arrestor shall be ensured at both ends.

iv. Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per provided **format**.
v. Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
vi. Availability of fire extinguisher at vicinity shall be ensured.

19.5.6 Inspection Of Electrical Installation / Appliances

i. Ensure proper earthing in electrical installation
ii. Use ELCB at electrical booth
iii. Electrical installation shall be properly covered at top where required
iv. Use appropriate PPEs while working
v. Use portable electrical light < 24 V in confined space and potentially wet area.
vi. Inspection shall be carried out as per provided **format**.

19.5.7 Inspection Of Elevator

i. Elevators shall be inspected by concerned supervisors once in a week as per provided **format**
ii. All elevators shall be inspected by competent person and validity shall be ensured.
iii. The date of third-party inspection and next due date shall be painted on elevator.

19.5.8 Inspection Of Excavation

Excavation activities shall be inspected as per provided **format**

19.5.9 Internal/ External HSE Audits/Inspections

i. All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed of by site in a time bound manner and reported back the implementation status.
ii. Corrective action and Preventive action on HSE issues raised by certification body issued by BHEL shall be implemented by site and reported to Site management.

20. Terms and Definitions:

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.

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”.

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 labors. 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.

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.

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. **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.

7. **Type of Incidents & Their Reporting:**
   The three categories of Incident are as follows:

8. **Non-Reportable Cases:**
   An incident, where the injured person is given medical help and discharged for work without counting any lost time.

9. **Reportable Cases:**
   In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

10. **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.

11. **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:

    Number of Reportable LTI x 1,000,000/ Total Man Hours Worked

12. **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:
    Days lost due to LTI x 1,000,000/ Total Man Hours Worked

13. **Incidence Rate:**
    Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:
    Number of LTIx1000/Average number of manpower deployed

14. HIRA:

Hazard Identification and Risk Assessment (HIRA) is a process of identifying Hazards in work area and then assessing them properly

15. Method Statement:

A method statement is prepared by the Execution/ Engineering Department detailing the steps, equipment, competencies and safety precautions required for carrying out any activity

16. Job Safety Analysis:

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. Other terms used to describe this procedure are job hazard analysis (JHA) and job hazard breakdown.

17. Safety Walk:

It's conducted periodically by an official - it's a walk through a portion or whole of a site as a HSE officer who notes down HSE observations, speak to concerned workmen and supervisor on observation, get the same corrected with personal follow up- this sends out a strong message on Management's commitment to safety.

18. Heavy & Complex Lifting:

A heavy and complex lifting activity includes:

1. Lifting above 20 Tons
2. Tandem Lifting using multiple cranes
   Total load exceeding 75% of capacity of crane. Depending up the condition of cranes, hydra cranes, winch machines & other lifting accessories
3. Lift of unusual difficulty or geometry or rigging
4. Lift over operating units
5. Any other lift as decided by site HSE / Erection

19. Safety Committee:

As per the BOCW, Safety Committee shall be constituted if there are more than five hundred or more construction workers are employed at any site. As per the Factories Act, 1948 it is for 250 workers. It shall be represented by equal number of representatives of employer and construction workers.

20. Night Work:

Work conducted after sunset when only a fraction of total manpower is available



ANNEXURES

ANNEXURE A

Medical Centre & Ambulance

A. Medical Centre

1. Paramedical staff
    a. When < 500 workers, 1 Trained Male Nurse (round the clock deployment)
    b. When >=500 workers*:
        i. Registered Medical Practitioner (Qualified MBBS) to be deployed for at least 8 hours in a day, 5 days per week
        ii. 2 Trained Male Nurses (round the clock deployment)
2. All articles as per Schedule IV of BOCW Central Rules, 1998 to be made available in the Medical Centre (given under for convenience)
3. Basic Facilities/ Requirements to be provided as per location eg. Refrigerator, Air Conditioner, Anti Venom Serums etc.
4. Tie-ups with speciality hospitals to be ensured for referring serious patients

* In case the number of workers is envisaged to exceed 500, a medical practitioner is to be engaged.

SCHEDULE IV (BOCW CENTRAL RULES, 1998) ARTICLES FOR AMBULANCE ROOM
[SEE RULE 226 (C)]

i. A glazed sink with hot and cold water always available.
ii. A table with a smooth top at least 180 cm x 105 cm.
iii. Means for sterilising instruments.
iv. A couch.
v. Two stretchers.
vi. Two buckets or containers with close fitting lids.
vii. Two rubber hot water bags
viii. A kettle and spirit stove or other suitable means of boiling water.
ix. Twelve plain wooden splints 900 cm x 100 cm x 6 cm.
x. Twelve plain wooden splints 350 cm x 75 cm x 6 cm.
xi. Six plain wooden splints 250 cm x 50 cm x 12 cm.
xii. Six woollen blankets.
xiii. Three pairs of artery forceps.
xiv. One bottle of spiritus annemia aremations (120 ml).
xv. Smelling salt (60 gm).
xvi. Two medium size sponges.
xvii. Six hand towels.
xviii. Four kidney trays.
xix. Four cakes of toilet, preferably antiseptic soap.
xx. Two glass tumblers and tow wine glasses.
xxi. Two clinical thermometers.
xxii. Two tea spoons.
xxiii. Two graduated (120 ml) measuring glasses.
xxiv. Two minimum measuring glasses.
xxv. One wash bottle (1000 cc) for washing eyes.
xxvi. one bottle (one litre) carbolic lotion 1 to 20.
xxvii. Three chairs.
xxviii. One screen.
xxix. One electric hand torch.
xxx. Four first-aid boxes or cupboards stocked to the standards prescribed in
xxxi. An adequate supply of tetanus toxide.
xxxii. Injections—morphia, pethidine, atrophine, adrenaline, coramine, novocaine (6 each).
xxxiii. Cramine liquid (60 ml).
xxxiv. Tablets—antihistaminic antispasmodic (25 each).
xxxv. Syringes with needles—2 cc, 5 cc, 10 cc and 500 cc.

xxxvi. Three surgical scissors.
xxxvii. Two needle holders, big and small.
xxxviii. Suturing needles and materials.
xxxix. Three dissecting forceps
xl. Three dressing forceps
xli. Three scalpels.
xlii. One stethoscope and a B. P. apparatus.
xliii. Rubber bandage—pressure bandage.
xliv. Oxygen cylinder with necessary attachments.
xlv. Atropine eye ointments.
xlvi. I. V. Fluids and sets 10 nos.
xlvii. Suitable, foot operated, covered, refuse containers.
xlviii. Adequate number of sterilised, paired, latex hand gloves.

B. Ambulance

1. When number of workers is <500:
   If the distance to a major hospital capable of handling critical injuries expected at Site is <= 50 KM from Site, then 1 BLS (Basic Life Support)/ Type B Ambulance otherwise ALS* (Advanced Life Support)/ Type D Ambulance
2. If no. of workers increases to >2000 workers one additional BLS Ambulance to be deployed
3. Minimum Articles as per Schedule V of BOCW Central Rules to be ensured in each Ambulance. (given under for convenience)

*Final call to be taken at Site in consultation with all the contractors

SCHEDULE V (BOCW CENTRAL RULES, 1998)
CONTENTS OF AMBULANCE VAN OR CARRIAGE
[SEE RULE 227]

The Ambulance Van shall have equipment prescribed as under:

a) General—a portable stretcher with folding and adjusting devices with the Head of the stretcher capable of being tilted upward. Fixed suction unit with equipment. Fixed oxygen supply with equipment. Pillow with case, sheets, blankets, towels, emergency bag, bed pan, urinal glass.
b) Safety Equipment-Flaros with life of three thousand minutes, floor lights, flash lights, fire extinguishers (dry power type), insulated guntlets.
c) Emergency Care Equipment—
   i. **Resuscitation**—Portable suction unit, portable oxygen unit, bag valve mask, hand operated artificial ventilation unit, airways, mouth gag tracheostomy adapters, short spine board, I.V. FLUIDS with administration unit, B. P. manometer cuff stethoscope.
   ii. **Immobilisation**—Long and short padded boards, wire ladder splints, triangular bandage—long and short spine boards.
   iii. **Dressing**-Gauze pads—100 m x 100 mm universal dressing 250 x 1000 mm, roll of aluminium foils—soft roller bandages 150 mm x 5 mm yards adhesive tape in 75 mm roll safety pins, bandage sheets, burn sheets.
   iv. **Poisoning**—Syrup of Ipecac, activated charcoal pre packeted dose, snake bit kit, drinking water.
   v. **Emergency Medicines**—As per requirement (under the advice of construction Medical Officer).

ANNEXURE A.1

Sample calculation for deduction of operational cost of facilities

Annexure A.1

Cost Calculation Methodology of Operation of Facilities (Data is indicative only)

(Period of 48 months is considered - shall be on actual basis)

A. Project Info:

Total time of Project	48 months
Project cost	1000 Crore
No. of packages	10 (A1-A10)

B. Item-wise Calculation:

Item	Nos.	Rate	Unit	Amount
Ambulance with Driver	2		Monthly/Unit	170000
Nurse/First aider	2 X 2 shifts	15000	Per month	30000
Training center one time cost	1	100000	Once	100000
Medical center one time cost	1	200000	Once	200000
Medicines at medical center	1	10000	Monthly	10000
Dust supression water tank	2	2000	Monthly	4000
Doctor	1	70000	Monthly	70000
Cleaning staff	1	12000	Monthly	12000
			Recurring monthly expenditure	296000
			Total one-time expenditure	300000

C. Package-wise Deduction Plan for a period of 48 months

Period (In Months)	6	36	6
	For 1-6 months	For 7-42 months	For 43-48 months
Cost to be incurred from contractors	7%	81%	12%
	1.17% per month	2.25% per month	2.00% per month

D. Calculation For One-Time Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10			
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000		
Share of common facilities one time running cost (in Thousands)	4	11	86	9	21	64	43	43	11	9	Individual Pkg value X Total one time running cost / All Pkg award values		
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48			
Month Count of work	6	8	47	31	9	39	43	34	9	8			
Deduction per month (in Thousands)	1	1	2	0	2	2	1	1	1	1	Total of One time Running cost (in thousands)	% deduction share of one time running cost per month	Nos. of active packages in month
Month No.													
1	1	1									2	1%	2
2	1	1	2								4	1%	3
3	1	1	2								4	1%	3
4	1	1	2								4	1%	3
5	1	1	2								4	1%	3
6	1	1	2	0			1				5	2%	5
7		1	2	0	2		1	1			8	3%	6
8		1	2	0	2		1	1			8	3%	6
9			2	0	2		1	1			7	2%	5
10			2	0	2	2	1	1			8	3%	6
11			2	0	2	2	1	1			8	3%	6
12			2	0	2	2	1	1			8	3%	6
13			2	0	2	2	1	1			8	3%	6
14			2	0	2	2	1	1			8	3%	6
15			2	0	2	2	1	1			8	3%	6
16			2	0		2	1	1			6	2%	5
17			2	0		2	1	1			6	2%	5
18			2	0		2	1	1			6	2%	5
19			2	0		2	1	1			6	2%	5
20			2	0		2	1	1			6	2%	5
21			2	0		2	1	1			6	2%	5
22			2	0		2	1	1			6	2%	5
23			2	0		2	1	1			6	2%	5
24			2	0		2	1	1			6	2%	5
25			2	0		2	1	1			6	2%	5
26			2	0		2	1	1			6	2%	5
27			2	0		2	1	1			6	2%	5
28			2	0		2	1	1			6	2%	5
29			2	0		2	1	1			6	2%	5
30			2	0		2	1	1			6	2%	5
31			2	0		2	1	1			6	2%	5
32			2	0		2	1	1			6	2%	5
33			2	0		2	1	1			6	2%	5
34			2	0		2	1	1			6	2%	5
35			2	0		2	1	1			6	2%	5
36			2	0		2	1	1			6	2%	5
37			2			2	1	1			6	2%	4
38			2			2	1	1			6	2%	4
39			2			2	1	1			6	2%	4
40			2			2	1	1	1		7	2%	5
41			2			2	1		1	1	7	2%	5
42			2			2	1		1	1	7	2%	5
43			2			2	1		1	1	7	2%	5
44			2			2	1		1	1	7	2%	5
45			2			2	1		1	1	7	2%	5
46			2			2	1		1	1	7	2%	5
47			2			2	1		1	1	7	2%	5
48			2			2	1		1	1	7	2%	5
Total	4	11	86	9	21	64	43	43	11	9	300	100%	

D. Calculation For Recurring Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10		
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000	
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48	Total of Recurring cost (in thousands)	Nos. of active packages in month
	6	8	47	31	9	39	43	34	9	8		
Month No.												
1	85	211									296	2
2	13	31	252								296	3
3	13	31	252								296	3
4	13	31	252								296	3
5	13	31	252								296	3
6	8	21	167	17			83				296	5
7		15	120	12	30		60	60			296	6
8		15	120	12	30		60	60			296	6
9			126	13	31		63	63			296	5
10			95	10	24	72	48	48			296	6
11			95	10	24	72	48	48			296	6
12			95	10	24	72	48	48			296	6
13			95	10	24	72	48	48			296	6
14			95	10	24	72	48	48			296	6
15			95	10	24	72	48	48			296	6
16			104	10		78	52	52			296	5
17			104	10		78	52	52			296	5
18			104	10		78	52	52			296	5
19			104	10		78	52	52			296	5
20			104	10		78	52	52			296	5
21			104	10		78	52	52			296	5
22			104	10		78	52	52			296	5
23			104	10		78	52	52			296	5
24			104	10		78	52	52			296	5
25			104	10		78	52	52			296	5
26			104	10		78	52	52			296	5
27			104	10		78	52	52			296	5
28			104	10		78	52	52			296	5
29			104	10		78	52	52			296	5
30			104	10		78	52	52			296	5
31			104	10		78	52	52			296	5
32			104	10		78	52	52			296	5
33			104	10		78	52	52			296	5
34			104	10		78	52	52			296	5
35			104	10		78	52	52			296	5
36			104	10		78	52	52			296	5
37			108			81	54	54			296	4
38			108			81	54	54			296	4
39			108			81	54	54			296	4
40			103			77	51	51	13		296	5
41			120			90	60		15	12	296	5
42			120			90	60		15	12	296	5
43			120			90	60		15	12	296	5
44			120			90	60		15	12	296	5
45			120			90	60		15	12	296	5
46			120			90	60		15	12	296	5
47			120			90	60		15	12	296	5
48			120			90	60		15	12	296	5
Total	143	388	5676	329	235	3102	2334	1772	132	96	14208	

ANNEXURE B

HSE Displays

A. Types of Displays

1. Based on Content

SN	Type
1.	**HSE Hazards & Precautions** Height Work, Housekeeping, Fire Safety, PPEs, Hot Work, Lifting & Rigging Activity, Site-specific Hazards – eg. for Refineries, Nuclear plants etc.; COVID Precautions; Environment Protection etc.
2.	**Other Displays, Signage etc.** HSE Policy, ISO Certificate, Safety Statistics, Assembly Area Location/ Route, Emergency Contact Numbers, Site Safety Rules & Regulations, Speed Limit, Work in Progress, Lock-Out Tag-Out (LOTO) Boards etc.

2. Based on Mounting

[Type 1]	[Type 2]	[Type 3]
Flex Sign Boards of Wooden Frame – directly mounted on Structures (walls, stairs, railings etc.)	Flex Sign Boards with Wooden Frame – mounted on metallic/ wooden legs – preferably double-sided	Coloured weather-proof Paintings on Walls (after due concurrence of BHEL/ Customer – Type 1 in case of no concurrence/ space)

B. General Requirements:

a. Displays should be weather-proof as per installation location, i.e. rain-proof, wind-proof and sun-proof.
b. Installation location and size to ensure visibility for the intended viewers (workers and moving personnel)
c. Displays to have at least 50% graphical elements preferably (as applicable). Language should be understandable by majority of the workers
d. Displays to be relevant to the hazards in the area
e. Proper installation to ensure boards don't obstruct activities and should not be prone to fall so as to pose danger
f. In case of multiple elevations (eg. Boiler, Power-house etc.), each elevation to have displays for applicable hazards including Height-Work, Housekeeping
g. For temporary work locations, posters/ boards may be erected and shifted after task is over
h. Minimum size of displays should be A1 unless otherwise specified
i. In case of damage, displays shall be reviewed and repaired/ replaced
j. In areas where night work is envisaged, fluorescent displays shall be installed and these should comprise of at least 20-30% of total displays
k. Total Number of displays to be not less than 1 per 10 workers and are to be dynamically updated based on number of workers

C. Area-wise Displays

Below is list of Area-wise displays that are to be installed at Sites (Numbers, locations may be adjusted for specific requirements)

SN	Area	Suggested Subjects	Minimum Size	Minimum Quantity	Locations
1	**Walls/ Foundations/ Cement Structures etc. belonging to the package area**	Safety Hazards Prevention and other HSE Awareness content	**[Type 3]**	As per BHEL assessment from time to time	
2	**Site Interior Roads belonging to the package area**	At least every 20 meters: 1. Speed Limit Indication, Safe Driving board 2. Boards for hazard awareness	1.As needed **[Type 2]** **2.** A1 or equivalent each [**Type 2]**	As indicated	Sides of Roads; Height to ensure good visibility
3	**Specific Package Areas**	**A. Common** At entry to respective Package/ Work Area, each contractor to put up daily updated board with following for each shift: 1. Scope of work and start date 2. Emergency Contact Numbers 3. Emergency Assembly Location, Escape Plan 4. Locations and supervisors of various gangs in the area, 5. Current Work permit Details 6. Safety Supervisor Location assignments - Names, Mobile Nos., Assigned Locations 7. Details (Name, Contact No. etc.) of Package In-charge - Contractor & BHEL 8. Details (Name, Contact No. etc.) of Safety In-charge - Contractor & BHEL 9. LTI Free Man-days & details of last LTI also to be indicated In addition, Area-Specific Displays as indicated in Table 1	**A0** **[Type 2]**	1 per Package Area	Entry/ Ground Level

Table 1

(Area/ Package-wise HSE Display Plan – As applicable)

Prepared By (Subcontractor)				
S. No.	**Area**	**Suggested Minimum No. of Displays & Types**	**Type**	**Numbers Installed**
1	Boiler	3 per working elevation	**[Type 1]**	
2	Powerhouse	5 per elevation	**[Type 1]**	
3	ESP	5 Per Pass	**[Type 1]**	
4	Buildings	5 per elevation	**[Type 1]**	
5	Cooling Tower (NDCT/ IDCT/ ACC)	20 per Structure	**[Type 1]**	
6	Chimney	20 per Structure	**[Type 1]**	
7	Fabrication Yard	10 per Yard	**[Type 2]**	
8	Batching Plant	5 per Plant	**[Type 1]**	
9	Material Storage Yard – Open	20 per Yard	**[Type 2]**	
10	Material Storage Shed – Semi-Closed/ Closed	10 per Shed	**[Type 1]**	
11	Electrical Booths	2 per booth + Line diagram, Emergency contact details	**[Type 1]**	
12	Medical & First Aid Centre	2 per Centre	**[Type 1]**	
13	Rest Shed	2 per Shed	**[Type 1]**	
14	Canteen	2 per Canteen	**[Type 1]**	
15	Drinking Water Area	1 Per Outlet	**[Type 1]**	
16	Washing Water Area	1 Per Outlet	**[Type 1]**	
17	Training Centre	10 per room	**[Type 1/2]**	
18	Assembly Area	5	**[Type 1/2]**	
19	Stairs	1 per landing elevation	**[Type 1]**	
20	Cylinder Storage Area	5 + Signage: Type of Gas, Empty, Filled etc.	**[Type 1/2]**	
21	Labor Colony	Electrical Safety with Distribution Plan/ Line Diagram - 1 COVID Precautions Posters – 5 Safety Awareness Posters – 10 Hygiene awareness posters - 2	**[Type 1]**	
22	Others	As per requirement	**[Type 1/2]**	

Date:

Sign (Contractor) **Sign (BHEL)**

ANNEXURE C

HSE Tools/ Equipment/ Devices

Following equipment conforming to relevant IS/ISO/BS Codes/ Standards in indicated quantities shall be ensured by subcontractor. This list is tentative, not exhaustive. Quantity and date/ period of deployment shall be as per site requirement.

A. HSE Tools/ Equipment/ Devices

SN	Item
1	Lifelines
2	Retractable Fall Arrestors
3	Safety Nets (10m X 5m) fire proof double mesh
4	Sky Climbers
5	Fire Blanket
6	Honey Bee Removal Suit & Kit
7	Scaffolding Pipes
8	Flashback Arrestors
9	Barricading Tape
10	Binoculars
11	Walkie-Talkies
12	LOTO kit
13	24-Volt light
14	Sand Buckets
15	Hard barricading Pipes
16	Standby Fire kits
17	Hand-held Megaphone
18	Small Public Address System
19	Foldable Stretcher
20	Height Rescue Kit (Non-Motorized)
	(Others:)

B. Test & Measurement Devices

SN	Device
1	ELCB Tester
2	Multi meter (Light cables)
3	Earth Resistance Meter
4	Lux Meter
5	Sound Meter
6	Anemometer
7	Breath Analyzer (Alcohol)
8	Multi-gas dozi-meter/ detector
9	Gas leakage detector / alarm
10	Gas monitor (confined space)
11	Radiation meter & Badges
12	Blood Pressure Monitor
13	Fire detectors
14	Hand held signaling light
	(Others:)

ANNEXURE D

Rest Sheds

1. Determining the Number, Sizes and Locations of Rest Shelters

i. **Numbers:**

The number of rest shelters shall be determined based on maximum number of workers at any one time (across all shifts). Formula is:

Wmax = Maximum number of workers at any time in the Site

Space per worker = 1.1 sq meter

Total space required, Tspace = Wmax X 1.1

Based on total space requirement calculated above, the number of rest sheds can be decided according to availability of locations and concentration of workers – so as to ensure the required space.

ii. **Locations:**

The rest sheds should be so located so as to minimize the distance to be travelled by the workers from their locations of work considering all the practical constraints

iii. **Other:**

The Rest shelter should be fenced so that it cannot be used as parking area.

2. Design & Construction of Rest Sheds

a. Permanent/ Long duration Rest Sheds

i. For locations where, permanent rest sheds can be constructed without possibility of removal for relatively long period of time, a semi-closed shed can be constructed covered with tin roof and supported with well-grouted beams. The floor of the shed to be preferably cemented/ solidified.

ii. Adequate structural requirements suitable to the local weather (wind/ rain etc.) to be ensured.

iii. The design of the rest shed to be approved by Civil Engineering Department of BHEL Site before commencing work

b. Temporary/ Movable/ Portable Rest Sheds

i. For locations where, permanent rest sheds cannot be constructed either due to non-availability of permanent location or other reasons, temporary rest shed shall be constructed.

ii. Temporary rest sheds shall comprise of Tent arrangement carried out by professional agencies

3. Amenities in Rest Sheds

a. Essential Amenities

Following amenities shall be essentially ensured in a rest shed:

i. Hygienic environment with regular cleaning and housekeeping (with records)
ii. Adequate illumination
iii. Adequate ventilation/ heating as per weather conditions
iv. Clean Drinking water source
v. Hand Washing area
vi. Toilets & Urinals
vii. Benches/ mats for sitting/ lying
viii. Any other essential requirement deemed necessary by the Site
ix. Dust bins of sufficient quantity/ size that are vacated each day/ as per requirement

b. Additional/ Optional Amenities

Following amenities are optional but are recommended to enhance the level of satisfaction of work force:

i. Hot/ Cold drinks (Tea, Coffee, Glucose etc.) as per requirement
ii. Snacks
iii. Fans/ Coolers/ Heating arrangements as per requirement and weather conditions
iv. A nice, welcoming interior design, music etc.
v. Water cooler

4. Health & Safety Requirements of Rest Sheds

Use of asbestos in construction is banned and shall not be used.
In addition, following essential Safety features shall be ensured in Rest sheds:

i. Availability of Fire extinguishers (preferably CO2 type)
ii. Display of Safety Posters
iii. Pest/ reptile protection
iv. Mosquito prevention measures

5. Note:

Any suitable closed spaces/ newly constructed buildings etc. available at project may also be used for the purpose of rest shed with due concurrence of BHEL

ANNEXURE E

Labor Colony

1. These Guidelines suggest minimum requirements. However, additional requirements based on feasibility and circumstances, while adhering to directions of GOI/District Administration/Local Authority guidelines to be considered
2. Norms for social distancing, training/ awareness, face masks, disinfection, sanitization, gate entry, quarantine, medical, action in case of suspect cases of COVID and other communicable diseases etc. to be followed as per Govt. and BHEL guidelines issued from time to time
3. Labor colony to be developed as close to the Site as possible to avoid lengthy commute
4. A "Suggestion Register" shall be made available at the labor colony for residents. The feedback shall be reviewed on weekly basis and acted upon by concerned Contractor. Same shall be reviewed periodically by authorized BHEL Site Official.
5. **Canteens, Latrines & Urinals, Washing Facilities, Creches, Residential Accommodation and other infrastructure/ facilities:**
   Numbers/ Quantities and Features of these facilities shall be in line with the following as applicable:

   a. BOCW Act & State Rules
   b. The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act & State Rules
   c. Factories Act & State Rules
   d. Other Relevant Acts & Rules

6. **Cleanliness & Hygiene/ Housekeeping:**
   a. Regular cleaning of the labor colony to be ensured.
   b. Daily cleaning of Sanitary facilities.
   c. Proper drainage system to prevent water-logging
   d. Regular fogging to prevent spread of mosquitoes
   e. Prevention of foul smell through necessary interventions
   f. Dust suppression as per requirement
   g. Cutting of Grass at regular intervals and other necessary measures to prevent pests & reptiles
   h. Stray animals to be banned from labor colony.
   i. Outside every common facility, eg. Toilet, washroom, food hall/ canteen etc., provision of washbasin with flowing water and soap (preferably liquid soap) to be ensured
7. **Power Supply Layout:**
   Electrical supply Layout of Labor Colony shall have the provision of Safety devices like MCBs, ELCBs etc. and to be clearly displayed
8. **Washing & Drinking Water Availability**
   a. Adequate water to be provided in line with: "Estimation of Water Requirements for Drinking and Domestic Use (Source: National Building Code 2016, BIS)"
   b. Drinking water tank to be cleaned every week and sticker for the same pasted on the tank
   c. Drinking water source should be tested as per IS 10500
9. **Waste Disposal:** Separate bins for dry, wet and biomedical waste to be installed. These bins to be evacuated regularly
10. **Training & Awareness/ Displays**
    a. **HSE Awareness Displays**: Posters/ banners/ boards to be displayed in labor colony. Subjects of displays shall be precautions for applicable hazards at work site.
    b. **Emergency Contact Numbers** including that of Doctor, Hospital, Labor Colony Supervisor, HSE Officials to be displayed prominently

11. **Doctor Visits:**
    Regular and need-based visits by Doctors to be ensured through tie-ups etc.
12. **Inspection & Review:** Regular inspection of labor accommodation to be carried out by the Contractor as per prescribed format. Last inspection date, inspector and next due date to be prominently indicated near main gate
13. Provision of a Fair Price shop in the premises to be ensured as per requirement
14. Adequate arrangements to be ensured in case of children/ families

ANNEXURE F

Toilets

Toilets (Latrines and urinals shall be ensured at Site and Labor Colony in accordance with the Inter-State Migrant Workmen Act, 1979 as given below:

LATRINES	URINALS
1. Latrines shall be provided in every establishment on the following scale, namely: - a. Where females are employed, there shall be at least one latrine for every 25 females; b. Where males are employed, there shall be at least one latrine for every 25 males: Provided that where the number of males or females exceeds 190, it shall be sufficient if there is one latrine for 25 males or females, as the case may be, up to the first 100, and one for every 30 thereafter 2. Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.	1. There shall be at least one urinal for male workers up to fifty and one for female up to fifty employed at a time: Provided that where the number of male or female workmen, as the case may be, exceeds 500 it shall be sufficient if there is one urinal for every fifty females up to the first 500 and one for every 100 or part thereof thereafter. 2. The urinals shall be designed and located so as to ensure privacy.

Important:

1. Where workers of both sexes are employed there shall be displayed outside each block of latrine and urinal a notice in the language understood by the majority of the workers 'For Men Only', or For Women Ónly', as the case may be.
2. The notice shall also bear the figure of a man or of a woman, as the case may be.
3. The latrines and urinals shall be conveniently situated and accessible to workers at all times at the establishment.
4. The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
5. Latrines and urinals other than those connected with a flush sewage system shall comply with the requirements of the public health authorities.
6. Water shall be provided by the means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.
7. At Site, on ground, Modular Bio-toilets as per industry standard specifications and regular professional cleaning shall be ensured. The toilets should be sufficient in number and easily accessible to workers from every work area
8. At Site, in various elevations, suitable urinals with proper drainage to be ensured at each elevation in line with IS 2064 (1993). Same to be cleaned regularly

ANNEXURE G

Fire Extinguishers

SN	Type of Fire Risk (Class of Fire)	Extinguishing Medium & Relevant INDIAN STANDARD	Scale of Equipment (Minimum recommended)
1.	**CLASS 'A'** Fires involving ordinary combustible materials like wood, paper, textiles, rubber etc. (Ordinary hazard or low fire load)	WATER Soda acid type, water type (gas pressure) and water type (constant air pressure) IS: 934 -1976; IS: 940 -1976; IS: 6234 -1971	For every 600 square meter floor area or part, one 9-litre capacity. Minimum 4 numbers per floor or room; should not be required to travel more than 15 meter to reach any extinguisher.
2.	**CLASS 'A'** (Extra hazard &high fire load)	-do	-do – (Also, consult local fire authority).
3.	**CLASS 'A'** (Special hazards)	-do	-do – Extra provision For every 100 square meter floor area or part, one 4.5 Kg. CO2; minimum 2 numbers per room; should not be required to travel more than 10 meter to reach any extinguisher.
4.	**CLASS 'B'** (Fires in flammable liquids like oils, solvents, petroleum, products, varnishes, paints, etc. where blanketing effect is essential) (Storage and handling in small quantities)	FOAM / CARBON DIOXIDE / DRY CHEMICAL POWDER IS: 933 -1976; IS: 2878 1976; IS: 2171 1976; IS: 4308 -1982	For every 50 square meter floor area or part, 2 numbers 9 -liters foam or 5 kg dry powder; should not be required to travel more than 10 m in the area of storage to reach any extinguisher.
5.	**CLASS 'B'** (Bulk storage other than in tank form))	-do -	-do- (but minimum 3 numbers per room)
6.	**CLASS 'C'** (Fires involving gaseous substances under pressure where it is necessary to dilute the burning gas at a very fast rate with an inert gas or powder) (storage and handling of gas cylinders)	CARBON DIOXIDE / DRY CHEM. POWDER. The best way to extinguish such fire is by stopping the flow of fuel gas to the fire. Container is kept cool with water spray. IS: 2878 1976; IS: 2171 -1976; IS: 4308 -1982	For every 100 square meter floor area or part; 2 numbers, 10 kg powder extinguisher or 6 kg C02; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
7.	**CLASS'D'** Fires involving metals like magnesium, aluminum, zinc, potassium etc. where the burning metal is reactive to water and which require special extinguishing media or technique	SPECIAL DAY POWDER IS: 2171 -1976 IS: 4861 -1968	For every 50 square meter floor area or part, 2 nos. 5 kg special dry powder; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
8.	**MIXED OCCUPANCY** (electrical); Generators; Transformers; etc.	CARBON DIOXIDE DRY POWDER, IS: 2878 1976; IS: 2171 -1976	For every 100 square meter floor area or part one 10 kg C02. Minimum 2 numbers for every location should not be required to travel more than 10 meter to reach an extinguisher.
Note: Due to peculiarities of the power plant construction sites, there would be locations in the construction areas of Boiler, Turbine, Generator, Transformer, etc. where different types of fire risk (classes of fire) may co-exist. Special care shall be taken while selecting and installing portable fire extinguishers for such locations so that all types of fire risk that may co-exist, are adequately covered. Similar special care shall be taken for storage areas.			

a. All Electrical welding booths shall be equipped with appropriate Fire Extinguisher

b. Appropriate Fire Extinguishers shall be made within easy reach of all welding operations
c. Fire extinguishers shall be regularly tested and last checked date to be indicated on each. Master list shall be prepared with location and details
d. Providing appropriate fire-fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
e. Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labour colony etc. Such fire protection equipment shall be easy and kept open at all times.
f. 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.
g. 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.
h. 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.
i. Emergency contacts nos. must be displayed at prominent locations
j. 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.

ANNEXURE H

HSE Compliance Certificate

Bill Ref no:_____Date:_____

NAME OF THE AGENCY: _____ Work-Area/Package:_____

Sl. No.	Description	Remarks
1	**HOUSE KEEPING**:	
1.1	All working areas at site (specific to the agency) are free from garbage's, scraps & any other undesired non-plant materials. There is no encroachment in safe passage of man, material & T&P to carry out activities safely	
1.2	All the plant materials under the custody of the agency are stacked & stored properly.	
2	**GENERAL ILLUMINATION**:	
2.1	ALL the working areas at site & office of the agency including passages are having proper & sufficient illumination.	
3	**STATUTORY & REGULATORY REQUIREMENT**:	
3.1	Sufficient water for drinking & other purposes and sanitation in work area and labour colony are available.	
3.2	Periodical Medical check-up of workers & staff done regularly & report submitted to BHEL	
3.3	Regular EYE testing is done for Crane operators/Welders and data's are available with agency	
3.4	All the T&P, Cranes etc used by the agency are having proper T.Cs & Fitness certificate available from competent authority.	
4	**SAFETY COMPLIANCE:**	
4.1	Number of Tool box meetings between Safety officers, erection staff & workers of the agency held in this month with location mentioned	
4.2	All precautions & Safety measures including PPE compliances are taken before working at HEIGHT	
4.3	Permit for working at Height is taken & complied accordingly	
4.4	ELCB is used in Construction Power Supply source by the agency & Proper Distribution board and electrical cabling has been used by the agency and regularly checked by electrician & safety officer of the agency	
4.5	Unsafe areas barricaded properly &unsafe opening closed properly	
4.6	Proper Platforms & Hand-rails used In areas earmarked earlier	
4.7	Proper safety signage's, Slogans & Emergency contact phone numbers including FIRE contact nos. are made available by the agency in locations mentioned	
5	Whether any penalty imposed by BHEL towards non-compliance of above points.	

VENDOR'S SIGNATURE	
Erection Engineer	
HSE Officer	
Site-in-Charge	

BHEL'S SIGNATURE	
Erection Engineer	
HSE Officer	
Package-in-Charge	

ANNEXURE I

Activity-Specific Safety Precautions/ Controls

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General

The philosophy of hierarchy of controls as below shall be followed

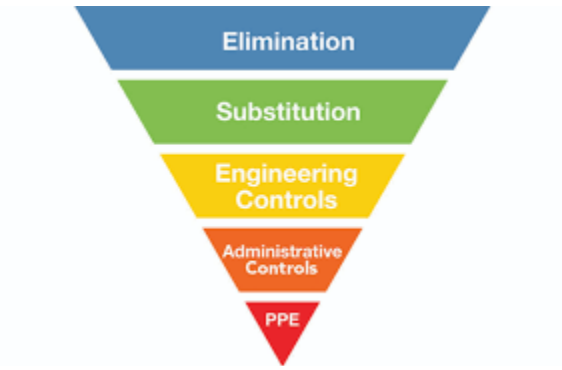


Fig. 1.1

It shall be ensured that there are multiple protections against any accident/ incident. For example, for height work there shall be safe platforms and walkways, Safety Nets and Lifelines for hooking double lanyard Safety harness by workers.

Monitoring and modifying worker behavior shall be part of ensuring safety. All personnel should be competent and trained for the job

Brief Safety guidelines for various hazardous activities are indicated below, besides the mandatory requirements based on Hazard Identification studies, HSE Procedures, Operational Control Procedures, Work Permits, applicable Indian Standard Codes and other provisions detailed in this document. Constant supervision at all times to be maintained by Execution & Safety Team to ensure implementation of these provisions.

1. WORK AT HEIGHT:

a. All work at height above 2 meter above ground level without complete platforms, handrails and other related fall protection shall require a work permit in the prescribed form. This shall require approval by the competent authority. The HSE officer of sub-contractors shall follow the checklist religiously by physically verifying the condition of the work area before recommending for approval.

b. Prior to the start of work at elevation, the HSE Officer involved with the work must meet the work supervisor to review the scope of work, and must review all the possible fall hazards and effective safety responses. The evaluation / analysis must be documented and kept on file and on site by the HSE Officer.

c. Whenever a fall hazard or other exposure exists for working at heights more than 2.0m/6ft, the nature and scope of work will be evaluated for conditions and environmental factors before selecting the appropriate fall protection system (active, passive or a combination of measures, as appropriate).

d. All Engineering and Administrative Controls including barricading, safe platform, Safety Nets etc. shall be made available at work location. Under no circumstances, there shall be total reliance on PPEs only

e. **Safety Nets**

   i. Contractor shall maintain sufficient stock of Safety Nets for deployment

   ii. Safety Nets as per IS: 11057:1984 should be used extensively for prevention / arrest men and materials falling from height.

   iii. The safety nets shall be fire resistant, duly tested and shall be of ISI marked.

iv. Safety Nets shall be deployed below all platforms where height work is envisaged. Duration of work, delay shall be no excuses for non-installation of Safety Net

f. 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.
g. Monkey Ladder shall be fitted with cages. Rope ladder should be discouraged.
h. In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
i. In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
j. For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor.
k. The procedures for the safety response to identified fall hazards developed and rescue plans must be reviewed with all individuals exposed to the hazards.
l. The HSE Officer must establish an inspection process of fall protection systems. Some equipment requires documented inspections by its manufacture on a regular schedule. Such equipment must have evidence of the inspection and re-certification process on it. This information must be reviewed before the equipment is actually used. Individuals must visually inspect the fall protection equipment before each use. Failure to complete this inspection process could result in serious injury or death.
m. Immediately remove from service any fall protection equipment that is identified as defective, damaged, or has been subjected to an impact. Damaged fall protective equipment must be destroyed to prevent re-use and not be discarded into trash containers, as the worn or damaged equipment could be unintentionally re-used.
n. Aerial lifting devices, excluding scissor lifts require the use of full body harnesses and lanyards in any elevated position.
o. Where Height related works are applicable then rescue team (consist of 5- 10 person) shall be identified and trained for potential rescue.

1.1 Personnel fall protection system must include:

a. Safety Harness

All height workers must use Full Body Safety harness with double lanyards with shock absorber (only). The primary lanyard is never unhooked until the secondary lanyard is secure. The design of the working platform should be such that under no circumstances, worker should have both lanyards unhooked while at height.

b. Lanyard

i. The type of work and the environment conditions determine lanyard and lifeline selection. If welding, chemical cleaning that may damage lanyards, connectors or lifelines, sandblasting, etc., either protect the components or use more appropriate type of system.
ii. Lanyards and lifelines must incorporate, or be used with, an appropriate deceleration (shock absorbing) device. Deceleration devices include rope grabs, rip-stitch lanyards, specially woven lanyards, tearing, or deforming lanyards, automatic self-retracting lifelines and lanyards which dissipate or limit the energy imposed on the employee during fall arrest.
iii. Once in use, the system's effectiveness is to be monitored. In some cases, a program for cleaning and maintaining the system may be necessary. Lanyard and lifelines must use locking snap hooks only and under

no circumstances must two lanyard snap hooks be connected.

c. Lifeline

All lifelines in general are to be made of min 12mm dia. steel rope (plastic coated) and tied to columns with 3 clamps at each end. Wherever columns are not available to tie the lifelines, the vertical posts as per the design below are to be provided after carrying out drop load test initially. A load of 240kg to be dropped off the mid-point of lifeline in this test.

d. Lifeline Post

DIAGRAM : LIFELINE POST

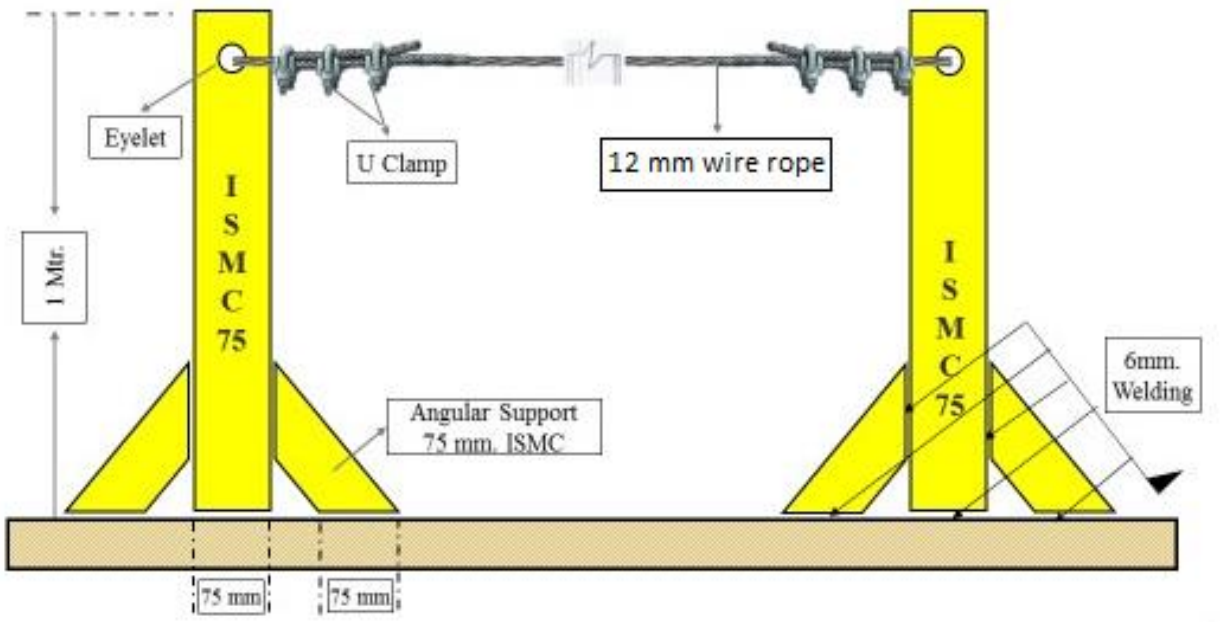


Fig. 2.1 Lifeline Post

i. The support at vertical post shall be fixed at end-to-end (welded/ bolted). The maximum length of one end to another end shall be 6 meters

ii. If the length of a lifeline is more than 6 meters, then intermediate vertical post(s) are to be used. Such intermediate post(s) will act as supports and the lifeline rope should simply pass through the eyelets (holes) of such supports without being anchored

iii. The lifeline need not be wrapped / clamped to any intermediate post

iv. Such intermediate posts must be used at an interval of every 6 meters

v. The post(s) in which the original lifeline is to be installed should be capable of sustaining a tensile stress of 2268 Kgs.

vi. In a horizontal lifeline installation, maximum allowable sagging is 500-600 mm

vii. For a single spun lifeline, no more than 3(Three Nos.) persons are allowed to work; for more than two workers, another lifeline should be installed

viii. Horizontal lifeline should be so installed that it does not impede safe movement of workers

ix. All the installation work must be carried out by competent person with adequate knowledge

1.2 Working Platform

a. 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.

b. <u>Precautions against the fall of Materials, Persons and Collapse of Structures:</u>

i. Every opening in the floor or a building or in a working platform shall be suitably barricaded to prevent the fall of persons by providing suitable fencing or railing whose minimum height shall be 90 cm.

ii. Adequate precautions should be taken such as the provision of fencing, or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered. Hard barricading shall be made at such places made of scaffolding pipe & clamps covered with reflective net. Cradle may be used for lifting materials - however this shall be made of MS angles and flats only and duly certified by the HSE officer. Operators may also use designed containers for lifting small tools.

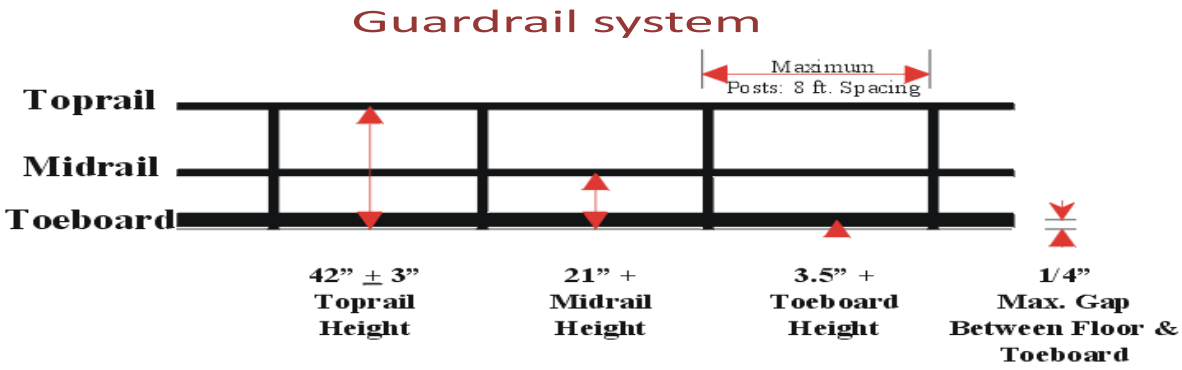
iii. Guardrails (including scaffolding) erected over/adjacent working areas must have the guardrails screened (opening < 0.5), to prevent material from falling outside the platform/decking.

iv. Guardrails must be able to withstand a 200-pound force exerted in any one direction.

v. Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.

vi. All openings through which workers are liable to fall should be kept effectively covered or fenced and indicated in the most appropriate manner.

vii. Guardrails and toe-board/barricades and sound platform conforming to IS: 4912-1978 and other Indian laws and regulations as depicted below should be provided.



<u>Fig. 2.2 Guard Rail System</u>

viii. Guardrails shall be provided to protect workers from falling from elevated work places. The rails are generally made of MS pipes of suitable dia. Rebar shall not be used for any handrails, ladder or cover purpose. Wherever the guard-rails and toe-boards cannot be provided:

a. adequate safety nets or safety sheets shall be erected and maintained; or
b. adequate safety harnesses shall be provided and used and / or
c. adequate fall arrestor shall be provided and used.

As mentioned under PPE clause, all these PPEs shall be defect free and regularly inspected for any defect. The full body safety harness shall have double lanyard only with max 1.8m length.

ix. The monkey ladders shall have sufficient fall arrestors. Adequate lifelines of 8mm steel wire rope shall be provided across the work area.

x. The HSE officer shall recommend appropriate PPEs after analyzing hazards and risks involved.

1.3 Scaffolding

All scaffolds shall be conformant to the relevant standards including IS 3696 and IS 4014 as applicable. A sketch of the scaffolds proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use. Only cup lock type scaffoldings will be allowed in site. Where cup lock type scaffolding arrangement is not feasible by the virtue of the location, in that case only pipe and clamp type scaffolding will be allowed.

a. The scaffolding work must be carried out by a competent person, who shall train the scaffold users on safety aspects
b. All scaffolds shall be erected / dismantled by scaffolding crew under direct supervision of competent scaffolding supervisors.
c. All scaffolds shall be capable of supporting 4 times maximum intended load and erected on sound, rigid footing, capable of carrying the maximum intended load without settling or displacement. Bamboo scaffolding is not permitted for use on site.
d. Each employee on the scaffold shall use an approved safety harness attached to an independent lifeline. The lifeline is to be securely attached to substantial members of the structure (not the scaffold itself) or to securely rigged lines, which shall safely suspend a worker in event of a fall.
e. Guard rails and toe boards shall be installed on all open sides and ends of platforms more than (2) meters above ground or floor
f. Scaffold planks must be at least 5 cm x 25 cm (2” x 10”) full thickness lumber scaffold grade or better.
g. Scaffold planks shall not span distances greater than 2.5 meters (8 feet).
h. Scaffold planks shall extend over end supports not less than 6 inches nor more than 12 inches and be secured to the scaffold. Scaffolding and accessories with defective parts shall be immediately repaired or replaced.
i. All scaffolding must be a minimum of two planks wide. No one may work from a single plank.
j. Scaffold planks must be inspected before use. Planks that have been damaged must be removed from the site.
k. Access ladders must be provided for each scaffold. Climbing the end frames is prohibited unless the design incorporates an approved ladder.
l. Adequate mudsills or other rigid footing capable of withstanding the maximum intended load must be provided.
m. Scaffolds more the 6 meters (20 feet) in height must be tied to the building or structure at intervals which do not exceed 4 meters (13 feet) vertically and 6 meters (20 feet) horizontally.
n. Do not overload scaffolds. Material should be brought up as needed. Scaffolding must not be loaded in excess of its rated capacity.
o. Barrels, boxes, kegs, blocks or similar unstable object must never be used as work platforms or to support scaffold.
p. Where persons must work under or pass under a scaffold then a 18 gauge wire mesh screen must be installed between the toe board and guard rail.
q. Employees exposed to overhead hazards while working on a scaffold will be protected by 5 cm (2”) thick planks.
r. Wooden/bamboo ladders shall not be allowed at any cost. Ladder’s rungs shall be fitted /welded

properly. Before every use the rungs should be checked for safe use.

s. Wooden scaffolds shall not be used in areas where fire / fire products are expected

t. Ropes made of jute / Plastic and other fire prone material shall not be used to tie up scaffolding components together

u. The platform should have permanent hand rail and mid rail with Toe board without fail.

v. All platforms are to be tightly planked for the full width of the scaffold, except as may be necessary for entrance openings. Platforms shall be secured in place.

w. On suspension scaffolds designed for a working load of 500 pounds, no more than two workers are permitted to work on the scaffold simultaneously. On suspension scaffolds with a working load of 750 pounds, no more than three workers are permitted on the scaffold simultaneously.

x. Requirements for different types of Scaffolds:

A. Suspended Scaffold

i. Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.

ii. Requirements for use are to be preapproved by HSE Head, under a specific Permit to Work.

B. Rolling Scaffolds

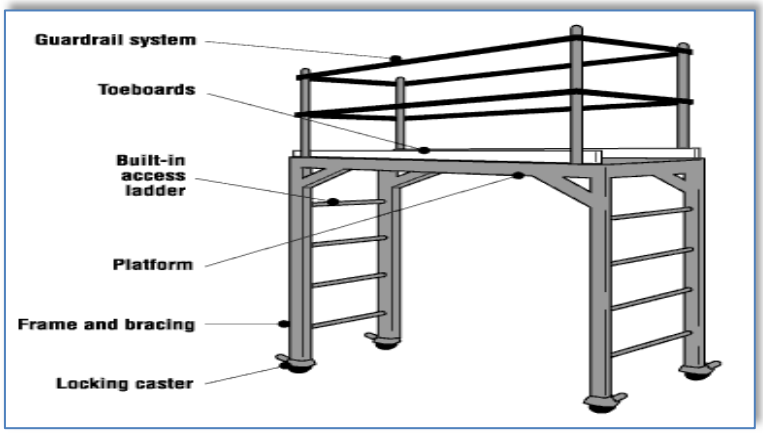
i. The height of rolling scaffolds shall not exceed three times the minimum base dimension.

ii. The minimum base dimension of rolling scaffold will be 1.25 meters (4 feet).

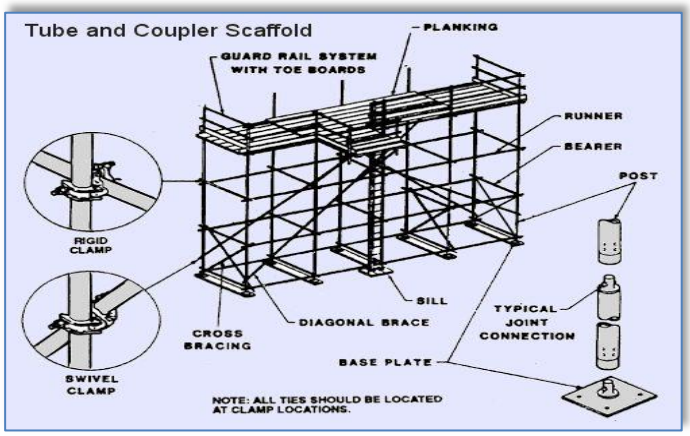
iii. Adequate help must be provided when moving a rolling scaffold.

iv. Secure or remove all loose materials, equipment and tools before moving a rolling scaffold.

v. No one is permitted to ride a rolling scaffold when it is being moved. Castor brakes must be locked-on when the scaffold is not being moved.



Rolling Scaffold



Tube & Coupler Scaffold

Fig. 2.3 Types of Scaffolds

1.4 Ladder Safety

A sketch of the ladders proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use

a. Safe Use of Ladders:

i. Fall protection is required when working on a ladder above 2 meters and when climbing above nearby guardrails.

ii. Ladders must be inspected prior to use and by a competent person quarterly, with documentation.
iii. Use portable ladders for height up to 4 M only
iv. Provide fixed ladders for height above 4 M
v. Place the ladder at an angle of 75 degrees (approx.) from the horizontal (1:4)
vi. Extend ladder at least 1 M above the top landing
vii. Secure top and bottom of the ladder firmly to prevent displacement- anti skid lining at the bottom
viii. Ensure that the width of the ladder is not less than 300 mm and distance between rungs is not more than 300 mm
ix. Provide landings of minimum size 600 x 600 mm at intervals not more than 6 M for fixed ladders. Check the ladders daily for any defects
x. Ensure that the areas around base and top of the ladder are clear. Getting on and off the ladder is more hazardous than using it. Use a mudsill if the ladder is to rest on soft, lose or rough soil
xi. Do not use ladders of conducting material near power lines, and only use ladders near power line or other energize system with exposed parts if they are confirmed locked-out and de-energized.
xii. Stand no higher than the fourth rung from the top for carrying out any job standing on a ladder.
xiii. Never reach out from a ladder to perform work where your belt buckle protrudes past the ladder rung.
xiv. Always face the ladder while climbing up or down
xv. Maintain three-point contact while climbing up or down a ladder i.e. two hands and one foot or two feet and one hand on the ladder at all the times.
xvi. Avoid climbing up or down a ladder while carrying anything in hands. Lift tools, equipment and materials with a rope.
xvii. Work from portable and extension ladders near guardrail where fall expose exists over the guardrail regardless of height, and above 2.0 mtr. heights from the working/walking surface will require the use of personal fall arrest equipment

2. EXCAVATION & CIVIL WORKS

All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

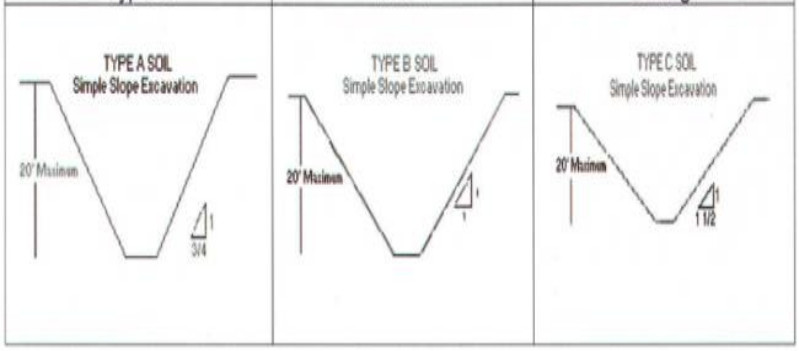
2.1 Excavation

The following safety measures are to be ensured before and during excavation:

a. All Excavation activities more than with depth of 1.22 meter or more shall require and Excavation Work Permit
b. Check for underground utilities like electrical / telephone cables, sewage, water lines and proper care has to be exercised to protect and prevent damage to it.
c. Electrical cables and service lines to be identified using cable detector/locator device before carrying out the excavation work
d. Proper and adequate slope is maintained while excavating
e. Adequate shoring or sheeting is done wherever require to prevent soil sliding
f. Safe access through ladder or steps for exit & entry to excavation
g. No material /excavated soil is kept within one meter from the edge
h. Safe way is planned and provided for movement of HEM /transport equipment near excavation
i. Safety helmet and shoes/gum boots are provided and worn by the workmen at excavation works

j. Dewatering arrangement is made where water seepage is prevailed.
k. Stop blocks are provided to avoid vehicles reversing into the excavated trenches
l. Danger signs /Caution boards are displayed at work spot
m. Hard Barricading is provided at excavated pits. It should be made of scaffolding pipe and clamp with reflective nets.
n. All Excavated area of depth 3mtr or more is to be hard barricaded with pipe.

Soil Type	Height/Depth ratio	Slope Angle
Stable Rock	Vertical	90 deg.
Type A	¾ : 1	53 deg.
Type B	1 : 1	45 deg.
Type C	1½ : 1	34 deg.



Determining Soil Type

Type	Description	Examples
A	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater.	Clay, silty clay, sandy clay, clay loam and in some cases: silty clay loam and sandy clay loam.
B	Cohesive soils with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	Angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases silty clay loam and sandy clay loam.
C	Cohesive soils with unconfined compressive strength greater than 0.5 tsf or less.	Granular soils such as gravel, sand and loamy sand; submerged soil or soil from which water is freely seeping; submerged rock that is not stable.

Fig. 3.1 Excavation Reference

2.2 Piling

Ensure the following precautionary measures before starting piling works:

a. Inspection of piling equipment by responsible person for its condition before initiating piling operation.
b. Checklist and OCP for piling to be prepared using manufacturer's instructions and used
c. Testing and its certification wire rope, slings, D-shackles, chain pulley blocks using in the process of piling work by competent person
d. Adequate support and secured foundation of the piling equipment to avoid toppling
e. Hoses should be lashed and adequately secured
f. Proper work platform is to be provided on piling frame
g. Safe work procedures and close supervision to prevent unsafe acts of operators/any unsafe conditions that may arise
h. Only experienced and trained operators are engaged for the piling operation
i. Provision of Personal Protective Equipment (PPE) like safety shoes/gumshoes/safety helmet/safety belt etc. and its use by their workmen.
j. Special care and precautions If work is near electrical live cables/ electrical equipment
k. Cordoning of work area to prevent un authorized entry
l. Guarding of revolving parts
m. Specific measures to prevent over turning of pile driver/missing of hammer/ hammer movement out of range

2.3 Batching Plant Operation

Following Safety considerations for batching plant are to be ensured:

1. Modern type batching plant should be used in which all the moving parts are protected and emergency

and safety features are incorporated.

2. Installation of external Electric moto-vibrators in the feeding hopper of all batching plants to reduce human intervention.
3. Installation of safety devices like pull-chord on both the sides of conveyor for stopping the conveyor in emergency
4. Workers carrying cement / sand to be given appropriate PPEs like respiratory masks & gloves.
5. Conveyor belt/rotating parts must be guarded properly.
6. Safety awareness shall be inculcated in workmen about the risk involved in rotating parts.
7. The agency shall ensure to erect the batching plant as per drawing including installation of all safety devices as provided by manufacturer and witnessed by BHEL Engineer in charge before starting of machine in future.
8. Safety audit to also focus on Batching plant.
9. The site shall impose penalty on the agency who has violated the safety norms as per contract.

2.4 Mobile Plant

Mobile plant includes tractors, trailers, dumpers, excavators, bulldozers, road rollers etc. for earthmoving purpose and concrete mixers, concrete transit mixtures, concrete pumps etc for concreting purpose. Due to the very nature of their function and movement in difficult terrains, congested areas, working in tandem with manual work and other operations the danger is inherent.

Automatic reverse camera with reverse horn connected with reverse gear is compulsory for all moving machineries.

Following Safety measures to be ensured for Mobile Plant:

a. Where movement around site is involved, routes should be planned, obstruction free and well maintained
b. Observe specified speed limits
c. Operating personnel should be aware of associated risks and its preventive measures
d. Only experienced, trained and authorized persons with valid license (wherever applicable) should operate the mobile equipment/vehicles
e. Provide and use Warning lights and reverse horn for cautioning the people around
f. Operation should be on level and stable ground with adequate working clearance.
g. Loading of out riggers/stabilizers should be well within safe ground bearing capacity
h. No person should be on equipment or vehicle during loading and unloading of material
i. Operators should be protected by warning barriers or switching off power when working in close proximity of overhead power lines
j. The equipment /vehicles should be well maintained and provided with effective brake system and other safety devices (wherever require)
k. Rotating parts of equipment should be adequately guarded
l. Provide necessary personal protective appliances and ensure its use by the operating personnel Ensure effective measures at source to control harmful emissions, dust, fumes contaminating atmosphere and cause health hazards to the operators and people in the vicinity.
m. No overloading/over stressing of vehicles/plant is allowed
n. Hoses, pipes, receivers, gauges and valves involved in carrying out hydraulic fluid/ compressed air should be checked for leaks and tested prior to operation.

o. Adequate safe clearance for swing and movement is to be judged during operation of Concrete mixer
p. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
q. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket
r. Operator leaving work spot should ensure that the equipment/vehicle is kept in neutral position and place on firm and level ground.
s. The hand brake should be kept in position and block road wheels as additional safety measure
t. Blades/buckets should be kept low while moving
u. The dozer blades should not be used as brakes except in emergency
v. The ground should be examined for its bearing capacity and general safety especially when operating road roller at the edges of slopes, embankments.
w. The roller should not be moved downhill with the engine out of gear
x. If operating near excavations the following precautionary measures are to be ensured
y. Barricading, edge protection to prevent fall of persons/vehicles over running while reversing etc.
z. Suitable support system and adequate allowance to avoid the danger of side collapsing
aa. Experienced signaler /attendant should be always accompanied with operator/driver for proper direction /signal and also to caution others in the working Zone during operation of mobile plant

2.5 Concrete Vibrators

a. Revolving parts/belt drives should be adequately guarded and Vibrating unit shall be completely enclosed and have suitable overload relays and effectively earthed
b. Ensure sufficient length of cable to the Vibrator.
c. Ensure electric starters and other accessories are firmly fixed adequately supported
d. Ensure locking of needle load while inserting needle in to the vibrator,
e. Ensure periodical lubrication and maintenance

2.6 Concrete Mixers

a. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
b. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket

3. WELDING & GAS CUTTING SAFETY (HOT WORK)

a. All Hot Work shall require a Hot Work Permit
b. Inbuilt Voltage Reduction Device (VRD) equipped arc welding machine will only be allowed for work.
c. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced.
d. All safety precautions shall be taken for welding and cutting operations as per IS-818.
e. When possible, items to be welded, cut, heated, etc. shall be moved to a safe location free of combustible or flammable material. If this is not possible, then all combustibles/ flammables that can be removed from the area shall be removed within a 35-foot circumference and a positive means of confining arcs and sparks generated by the process shall be ensured and additional person(s) shall be stationed as fire-watch for the area(s) still exposed, along with obtaining the Hot Work Permit as applicable.
f. Appropriate fire-fighting equipment is to be available in close proximity of any welding and gas cutting operations at all times suitable for the type of Fire.

g. Drums, tanks, and similar containers that have contained flammable or toxic material shall not be welded, cut, or heated until they have been made safe by water filling, thorough cleansing or similar accepted practices. The container shall also be ventilated during the welding, cutting, or heating process.
h. Proper ventilation is required for any welding or torch operations performed in a confined space.
i. Any welding or gas cutting operations performed on metals of toxic compounds or coating such as zinc, stainless steel, lead, cadmium, chromium, and beryllium shall be properly ventilated and/or proper respiratory protection shall be worn by any person that could be exposed to fumes, vapors, and gasses created by the welding and gas cutting processes.
j. Wherever it is practical, all arc welding operations shall be shielded to prevent direct light rays or sparks from contacting persons in the vicinity or from reaching areas normally used to travel through or into the vicinity. Where this is not practical, persons who shall be in the area are to use proper eye and skin protection. Other persons who are not participating in the welding or gas cutting operations are not to be allowed into the hazard zone.
k. Welders and other employees who are exposed to arc welding radiation shall wear suitable clothing and protective apparel to prevent burns and other types of ultraviolet radiation damage to the skin.
l. Arc welding machines shall be shut down when being moved or when they are not in continuous use. Electrode holders left unattended shall have electrodes removed and shall not be left where they might contact employees or conducting objects.
m. Arc welding power supply cable shall be of proper rating and material, e.g. copper.
n. Welders shall guard against allowing materials adjacent to or behind them to reflect radiation back toward them or towards others in the area. Reflected radiation can cause skin burns and eye flash burns.
o. Valve caps shall be in place when cylinders are not in use. Valve caps shall never be used for lifting the cylinder vertically.
p. Torches shall only be lit by approved strikers; never with matches, cigarette lighters, or hot-work.
q. Splatter / Slag Collector:

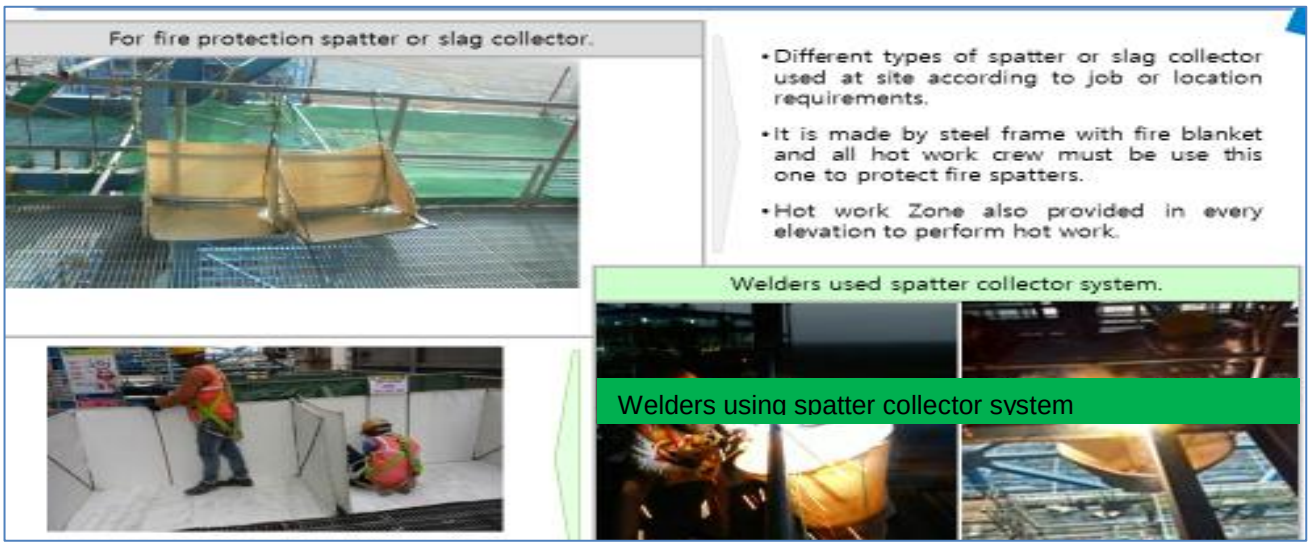


Fig. 4.1 Splatter / Slag Collector

While carrying out job at height, the sparks or molten slag shall be prevented from falling down by putting a fire-resistant (non-asbestos) sheet or patter/ slag collector or even MS Sheet. The passage of falling sparks

or molten slag shall be barricaded till ground floor and any cable/ tubes/ any other objects interfering in the passages hall either be removed or covered with Fire-resistant sheet or MS Sheet.

r. COMPRESSED GAS

i. All cylinder valves shall be closed when any work is finished and when any Cylinders are empty or being moved. Valve protection caps shall be placed and secured properly before gas cylinders are transported, moved or stored.

ii. Compressed gas cylinders shall be secured in an upright position with chain or appropriate means during storage & use. However, a trolley shall be used for transportation.

iii. Compressed gas cylinders shall always be secured from tipping or falling, whether in use, in storage or in transit. The cylinders shall always be secured upright, except during times when actually being hoisted or carried.

iv. When cylinders are transported by powered vehicle they shall be secured in a vertical position.

v. Regulators shall be removed when cylinders are not in use or are in transit, unless the cylinder is firmly secured on a special carrier designed for this purpose.

vi. Gas cylinders are not allowed to be used in man-basket when occupied.

vii. Cylinders containing oxygen or fuel gasses shall not be taken into confined spaces.

viii. Oxygen cylinders shall be stored a minimum of 6 meters from fuel gas cylinders or shall have an approved firewall between them.

ix. All cylinders shall be kept at a safe distance from welding or cutting operations or shielded from arc/ sparks / slag.

x. All cylinders shall be placed where they cannot become part of the electrical circuit.

xi. Oxygen and acetylene shall not be stored together. Oxygen must be separated from acetylene (or ANY fuel gas) or combustible material by at least 20ft or a barrier with a 30-minute fire resistance rating.

xii. All Cylinders should be stored upright in a designated area with labels for the type of gas. All applicable precautions to be ensured during storage

xiii. Oxygen and fuel gas regulators, hoses and associated equipment shall not be altered and shall be in proper working order while in use.

xiv. Compressed air can be extremely dangerous if allowed to penetrate the skin. As such, the use of compressed air to clean off yourself or other workers shall be strictly prohibited.

xv. All gas cylinders shall be stored in upright position. Suitable trolley shall be used for cylinder movement, the design of which shall be submitted to BHEL Engineer for approval.

xvi. No of cylinders shall not exceed the specified quantity as per OCP

xvii. 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.

xviii. All cylinder should be kept only in cylinder trolley.

xix. Cylinder shall be transported in upright vertical position by suitable mean.

4. LIFTING & RIGGING SAFETY

a. All Heavy / Complex Lifting operations as defined in Clause 6.12 shall require a Lifting Work Permit. A written rigging procedure and plan must be prepared for all individual heavy/ complex lifting operations.

b. All the cranes and lifting tools & tackles shall be inspected on daily / weekly basis as well as monthly by expert as per applicable formats.
c. In addition, inspection / certification as mandated by law shall be carried out wherein these shall be tested and certificates of fitness shall be obtained from 3rd party State Govt. approved competent agency before deploying at site and later periodically. BHEL shall be given advance intimation of any such inspections
d. The last date of Third-Party Inspection and the next Due date shall be conspicuously displayed on all cranes. A copy of certificate shall be pasted on operator's cabin of all the lifting equipment.
e. Specifically designed heavy steel plates lifting clamps shall be used for lifting heavy metal sheets. Manmade lifting clamp chapa shall not be used for lifting/shifting of plates.
f. Following requirements shall be mandatorily followed, wherever applicable:
    i. The manufacturer's instruction for maintenance shall also be followed. All safety measures shall be followed.
    ii. All tools tackles, lifting appliances; material-handling equipment etc. used by the subcontractor shall be of safe design and construction.
    iii. The operators, slingers and signalers shall be qualified as per IS 13367 (part-1):2003 "Safe use of cranes- code of practices".
    iv. There shall be a person responsible for co-ordination among cranes where multiple cranes are used, and lifting over load chart of the crane to be avoided.
    v. Mobile phone should be banned for crane operator and lifting operation. Only walkie talkie shall be allowed in rigging/Lifting purpose.
g. Lifts/Movements between 5 Tons and 20 Tons:
    i. Shall include a rigging plan, detailing schematic representation of the handling/lifting operations that must be included on the Method Statement.
    ii. When performing similar lifts of identical items, only one rigging plan need be prepared, provided each of the lifts can be performed in accordance with the rigging plan.
h. Lifts/Movements Less Than 5 Tons:
    i. An equipment rigging plan is not required for lifts less than 5 tons, safety measures are covered in the JSA. This could change as per BHEL requirement

i. Personnel Lifts (Man-Basket / Jhoola):

The design of personnel man basket shall be submitted to BHEL Engineer for approval before use. Relevant permit (Height work & others as applicable) shall be completed prior to lifting any people, along with a rigging plan.

i. A separate Lifeline / fall arrestor anchored to a fixed structure outside of Jhoola shall be provided for the workers inside the basket. All occupants of the basket shall have Safety Harnesses equipped with rope grabs, which are to be hooked to the vertical lifeline.
ii. Man-basket shall be used where access through ladders or scaffolding is not feasible.
iii. Man-baskets shall be designed and engineered by a manufacturer (job made man-baskets are not allowed, unless designed and tested by a certified engineer), and built robust with MS Angles and flats or plates or channels only.
iv. Guard rails top and mid, must be in place and screened-in to avoid material from falling out of

basket. The factor of safety shall be 200%.

v. It shall have a door with double latches and shall open inside. Anchor points shall be identified within the man-basket.

vi. The man-basket shall be thoroughly inspected and load tested and a trial run performed without personnel before being put to job.

vii. It shall be treated as a lifting tool (T&P Item) and shall undergo same certification cycle and inspection as other lifting equipment.

viii. An additional sling of required lifting capacity shall be fixed the man-basket main lifting point and attached to the crane above the ball or block.

ix. While lifting man-basket, the crane shall maintain a uniform speed of lift without any swing.

x. Once man-basket reaches the destination, the lift brakes shall be locked as long as the basket
   a. remains at that point. The same care shall be taken in its descent.

xi. As for hanging man-basket, the same shall be hung off a rigid structure with help U-shaped handle welded to man-basket. This shall be tested once in a year by a competent person.

xii. Use of Rebar steel for making and monkey-ladder must be avoided.

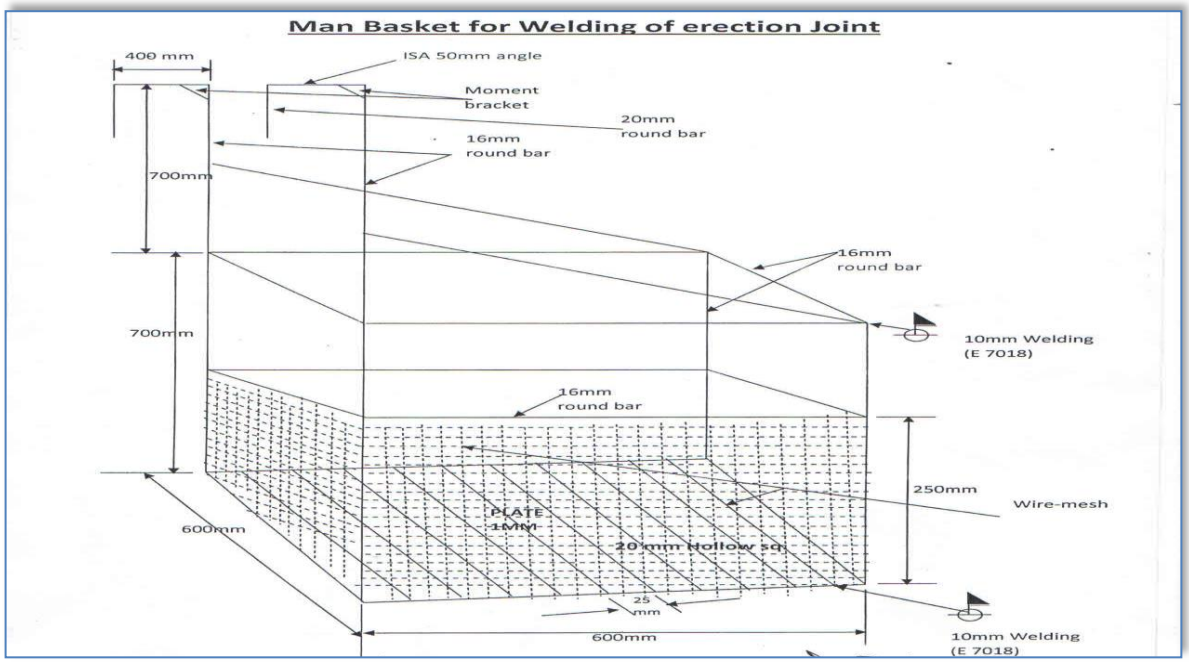


Fig. 5.1 Man Basket for Welding Erection Joint

4.1 Cranes & Hoisting Equipment:

This section provides the guidelines to ensure proper rigging and lifting activities are accomplished safely and in accordance with applicable specifications, codes, and regulations.

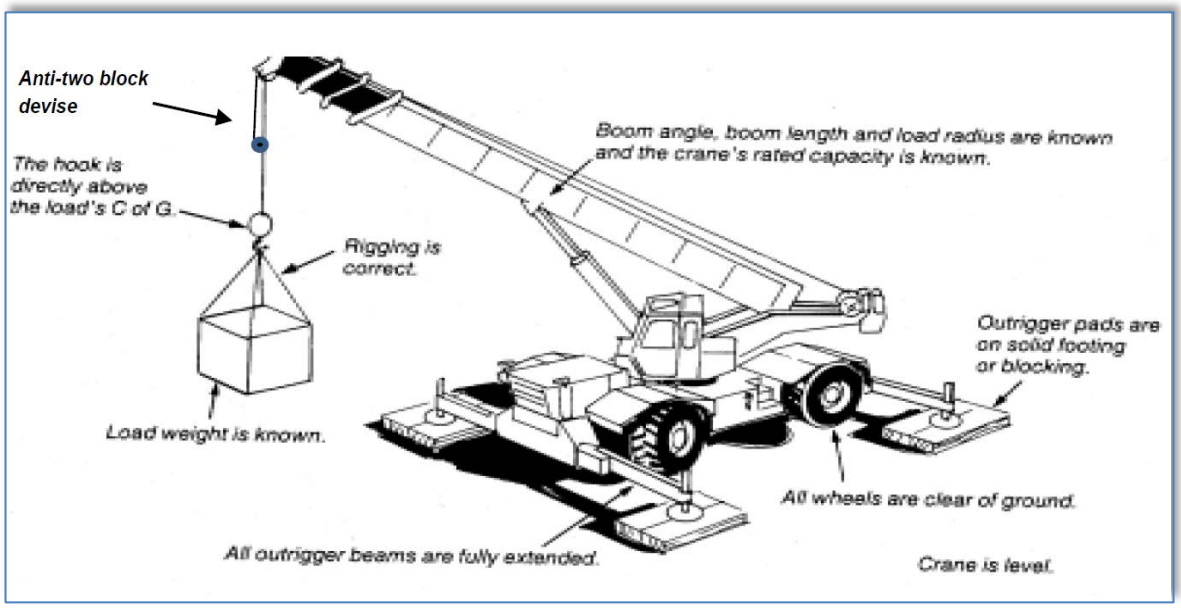


Fig. 5.2 Proper Crane Setup

a. On every crane or piece of hoisting equipment notices of all rated load capacities, recommended operating speeds, and any hazard warnings or special instructions shall be conspicuously posted. All instructions and warning shall be visible from the equipment operator ‘s station.
b. Cranes shall have an Anti-Two-block safety device installed
c. All mobile cranes shall have overload and backup alarms, load angle indicators and limit switches
d. All areas within swing radius of cranes that are potentially accessible by pedestrian, vehicular, or equipment movement shall be barricaded to prevent anyone or any vehicle or equipment from being struck by the crane or hoisting equipment, or its load(s).
e. No part of the lifting equipment or its load shall be within the distance as specified in the Indian Electricity Act from an energized power line
f. Cranes shall have annual certified third-party inspection and be inspected before use by the operator. Any defects shall be corrected before use. Logs of crane inspection shall be kept with the crane.
g. Make certain that the rigging personnel, material, and equipment have the necessary capabilities for the job and are in safe condition.
h. Communicate with person(s) directly responsible for accomplishing the work and / or work area to establish requirements/responsibilities and make certain that all preparatory work is complete.
i. Mats/Pads must be used on all lifting equipment, equipped with out riggers.
j. Pick and carry must have the load secured to the rig in front.
k. Only BHEL Approved Plate Lifting Spreader Beam configuration shall be used (Sample in Fig. 11.3.5.3)
l. Crane operators must follow the following:
    i. Pass an annual Operator’s Physical examination
    ii. Carry a valid training certification card at all time while operating issued by the Govt. or other recognized institute.

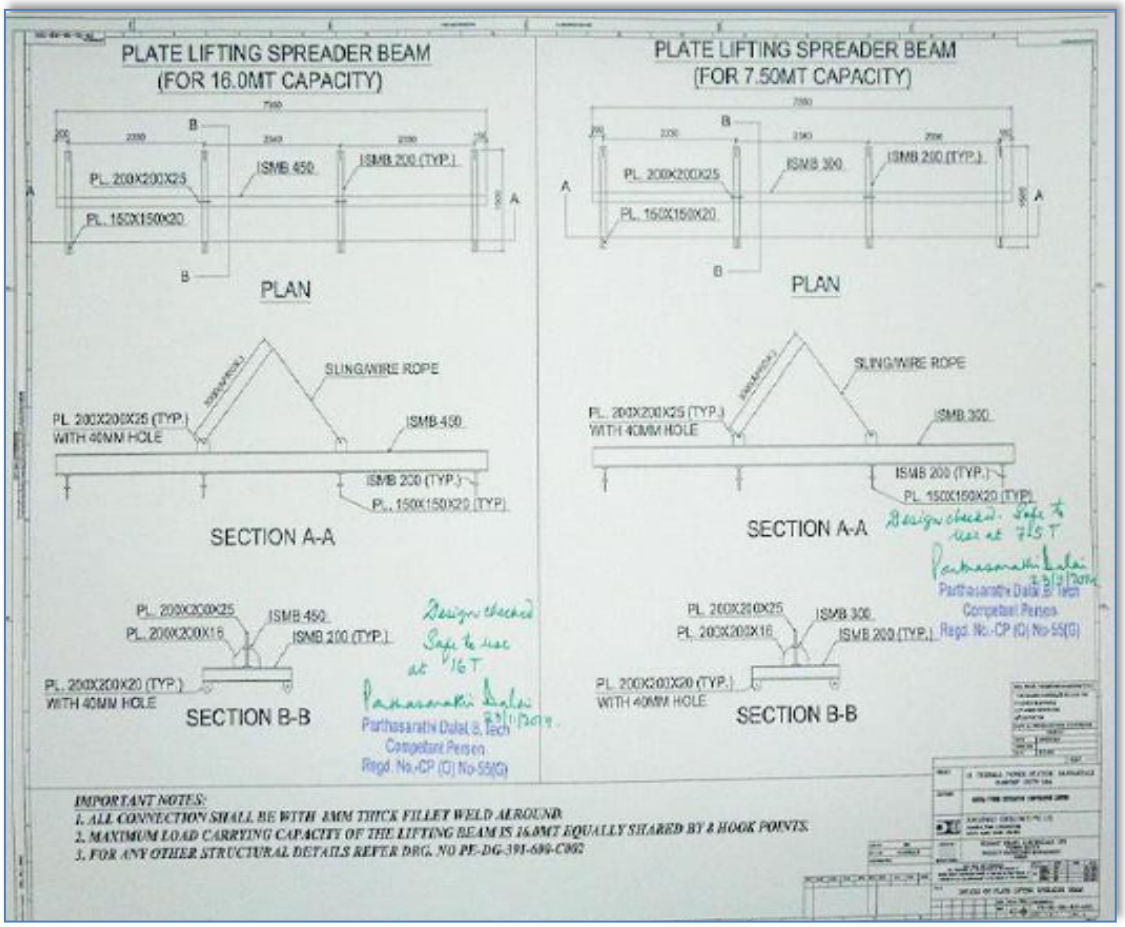


Fig. 5.3 Typical Plate Lifting Spreader Beam Configuration for 7.5 MT and 15 MT Loads

m. Safe Rigging Practices

i. Review the planned operation and requirements with the operator and rigging crew.

ii. Ensure a pre-lift meeting is conducted with crane operator, tagline operator, signal personnel, and Safety Manager.

iii. Designate a qualified person from the rigging crew to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desire clearance by visual means.

iv. Clear the lift area of all unnecessary personnel.

v. Hydras shall only be allowed for loading & unloading works & shall not be allowed to move with load

n. Rules for Safe Rigging

i. Use loops, thimbles and corner pads to prevent damage to slings when used around corners or on cutting edges.

ii. Never allow wire rope to lie on the ground for any length of time or on rusty steel or near solvents, chemicals or corrosive substances.

iii. Slings must not be pulled from between or under loads with load resting on the sling.

iv. Keep all rope away from flame cutting or welding operations.

v. Never use rope as sling material.

vi. Never wrap a wire rope completely around a hook.

vii. Do not bend wire rope near any attached fitting.

viii. The sling must be selected to suite the most heavily loaded leg rather than the total weight when using multi-legged sling to lift loads in which one end is heavier than the other.

ix. When using 3 and 4-legged sling configurations, any two legs must be capable of supporting the entire load.

x. Where possible, wire rope choker hitches must include a shackle with the eye around the shackle pin to prevent breaking wires of the choke. The choker hitch must be “snugged down” prior to lifting, not after tension is applied.

xi. Unless authorized by the hook manufacturer when more than two rope eyes are placed over a hook, install a shackle, pin resting in the hook, and place the rope eyes in the bowl of the shackle.

xii. Properly rig all loads to prevent dislodgment of any part.

xiii. Use guide ropes or tag lines to prevent the rotation or uncontrolled motion of the load when necessary.

xiv. Loads must be safely landed and properly blocked before being unhooked and unslung. Tag lines must not be used in situations that jeopardize the safety of the lift.

xv. Lifting beams must be plainly marked with their weight and designed working load and must only be used in the manner for which they were designed.

xvi. The hoist rope or chain must never be wrapped around the load. The load must be attached to the hook by slings or other rigging devices that are adequate for the load being lifted.

xvii. Multiple part lines must not be twisted around each other.

xviii. The hook must be brought over the center of gravity of load before the lift is started.

xix. If there has been a slack rope condition, determine that the rope is properly seated on the drum and in the sheaves prior to lifting.

xx. Keep hands away from pinch points as the slack is being taken up.

xxi. Leather gloves are recommended when handling wire rope.

xxii. Avoid impact loading caused by sudden jerking when lifting or lowering. Lift the load gradually until the slack is eliminated.

xxiii. Never ride on a load that is suspended.

xxiv. Avoid allowing the load to be carried over the heads of any personnel.

xxv. Never work under a suspended load until the load has been adequately supported from the floor and all conditions have been approved by the supervisor in charge of the operation.

xxvi. Never leave a load suspended unless emergency evacuation is required.

xxvii. Never make temporary repairs to sling.

xxviii. The capacity of a sling is determined by its angle, construction, type of hitch and size.

xxix. Never lift loads with one leg of a multi-leg sling until the unused legs are made secure.

xxx. Never point load a hook unless it is especially designed and rated for such use.

xxxi. Make certain that the load is broken free before lifting and that all legs are taking the load.

xxxii. When using two or more slings on a load make certain all slings are made from the same materials.

xxxiii. Lower the loads on to adequate blocking to prevent damage to the slings.

xxxiv. Materials and equipment being hoisted must be loaded and secured to prevent any movement which could create a hazard in transit.

xxxv. The weight of the hook, load block and any material handling devices must be included when determining crane capacity.

xxxvi. Calculated weights cannot exceed load chart without written approval.

xxxvii. Personnel must be completely clear of loads being picked up or set down by crane. Tag lines will be used to control the loads. Loads must not be touched by hand while placing/ moving.

o. Slings

The following are rules for safe use of synthetic slings:

i. Synthetic slings must be marked to show the rated capacity for each type of hitch and type of web material.

ii. Nylon web slings must not be used where fumes, vapors, sprays or mists or liquids of acids or phenolic are present. Web slings with aluminum fittings must apply in this category.

iii. Synthetic web slings must be removed from service and destroyed if any of the following conditions are present:

a. Acid or caustic burns
b. Melting or charring of any part of the sling surface
c. Snags, punctures, tears or cuts
d. Broken stitches
e. Distortion of fittings
f. Synthetic web slings of polyester or nylon must not be used at or come in contact with temperatures in excess of 82°C
g. Polypropylene web slings must not be used at or come in contact with temperatures in excess of 93°C
h. Insulated hooks must be tested yearly to ensure insulation integrity to at least manufacturer's specifications.

p. Wire Rope Slings must be removed from service and destroyed if any of the following conditions are present:

i. In (10) randomly distributed wires broken in one (1) rope lay, or five (5) broken wires in one (1) strand in one (1) rope lay.
ii. Wear or scraping of one-third the original diameter of outside wires.
iii. Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope structure such as:
iv. Evidence of heat damage.
v. End attachments that are cracked, deformed worn.
vi. Corrosion of the rope or end attachments.

q. Metal mesh slings must be immediately removed from service if any of the following conditions are present:

i. A broken weld or broken brazed joint along the sling edge.
ii. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.
iii. Lack of flexibility due to distortion or corrosion.

r. Requirements of Plate Clamps:

i. The rated load of the plate clamp must be marked on the main structure.

ii. Care must be taken to make certain the load is correctly distributed for the plate clamp being used.
iii. Do not allow load or plate clamp to come into contact with any obstruction.
iv. The plate clamp must not be used for side pulls or sliding the load.
v. When lifting stainless steel or special alloys, ensure plate clamp is designed for use on the specific metal.

s. Signaling Practices:

- The "slinger" is responsible for attaching and detaching the load to and from the crane. He shall:
  – have received appropriate training on general safe lifting operations;
  – be capable of selectings lifting gears suitable for the loads;
  – liaise with the operator and direct the movement of the crane safely.
- The "signaller" is responsible for relaying the signal from the slinger to the crane operator. He shall:
  – have received appropriate training on general safe lifting operations;
  – be able to direct the movement of the crane and loads.

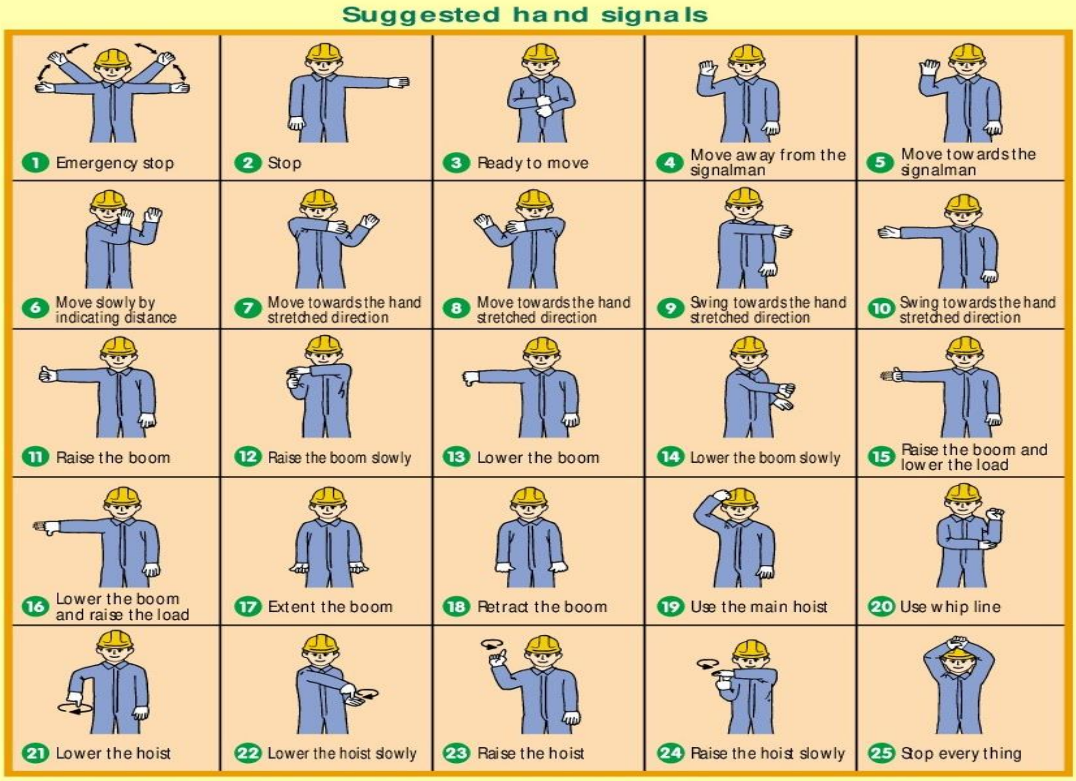


Fig. 5.4 Recommended Signaling Practices

5. DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured, besides using the Work Permit:

a. All roads and open areas adjacent to the work site shall either be closed, suitably protected or restricted for movement
b. 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.

c. 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.

6. T&PS GENERAL

a. All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test /calibration certificates bearing endorsement from competent authority of BHEL.
b. 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.
c. Tagging and punching in all lifting tool is compulsory with SWL, sr. no. and due date.
d. All T&Ps shall be inspected by authorized Third Party agency as per applicable frequency. BHEL shall be kept informed of any such scheduled inspection
e. All T&Ps shall be internally inspected in each quarter and colour coded.

7. CHEMICAL HANDLING

a. Displaying safe handling procedures & MSDS for all chemicals such as lube oil, acid, alkali, sealing compounds etc. at work place.
b. 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.
c. The used containers of chemicals shall be segregated and disposed of suitably
d. In case the used containers need to be re-used, all traces of the chemical to be removed by thorough cleaning with detergents etc. under trained supervision

8. ELECTRICAL SAFETY

a. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
b. No PDB or any other distribution board shall be more than 03 (three) years of purchase. Only modern PDB with industrial sockets as shown in layout below to be allowed to use at site.
c. Power supply to all equipment at site to be routed through MCBs of appropriate rating. A 'Power Supply Distribution Plan' shall be prepared and submitted to BHEL Engineer for approval
d. All power supplies through cables shall be underground or overhead with height > 3mtrs.
e. All power distribution boxes shall be locked and the key controlled by site management of concerned subcontractor.
f. All individual equipment & tools at site shall be powered through Earth Leakage Circuit Breakers of 30 mA sensitivity.
g. These MCBs and ELCBs shall be regularly tested as per Clause 14
h. All fuses and fuse wires shall be of standard size and rating.
i. All electrical appliances used in the work shall be in good working condition and shall be properly double earthed other that armour earthling.

j. All extension boards shall have separate switches for all sockets / connections.

k. All portable electric tools used by the subcontractor shall have safe plugging system (industrial top & socket) to source of power and be appropriately earthed.

l. Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts especially in confined spaces like inside water boxes, turbine casings, condensers etc.

m. Electrical appliance shall have proper earthing and for appliances equal to & more than 415V shall have two separate earthing (as per IS-3043-1987)

n. Portable Electric Lights

i. Portable electric lights used in wet or potentially wet locations must be either low voltage type (24 volts or less) or protected by a GFI (ground fault interrupter).

ii. They must be visually checked before each use and periodically while in use to assure their original integrity is maintained.

iii. Cords with cuts, breaks, deep abrasions, etc. shall be taken out of service immediately.

iv. Repairs to extension cords shall only be performed by qualified/ licensed electricians.

v. Must not be allowed to lie in wet or potentially wet areas.

o. Underground Cables:

i. Every electric line or cable of unknown origin that is discovered or exposed during a digging, drilling, probing, or similar operation is to be considered as energized and life threatening.

ii. The senior company employee on the site will ensure that all necessary safety precautions are taken in order to isolate the line from all workers and the public.

iii. Such precautions may include halting the operation if appropriate.

iv. The senior company employee on the site is to then contact the proper authorities to have the line identified and either confirmed to be abandoned and/or made safe for continuing the work.

v. Any and all underground lines that are discovered or become severed must be considered energized on both sides, and be treated accordingly.

p. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL

q. The subcontractor shall use only properly insulated and armoured cables and conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.

r. BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the risk & cost of the subcontractor.

s. No maintenance work shall be carried out on live equipment

t. 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

u. The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

v. Wiring and Branch Circuits Must be protected by a proper amperage over-current device such as a HRC fuse or circuit breaker. Such installations must be located so as to prevent physical damage to the wire conductors & panels.

w. The sub-contractor shall supply modern power distribution board of different combination (1-phase & 3-phase). All the distribution of power should be through modern PDB. Equipment drawing is mentioned below.

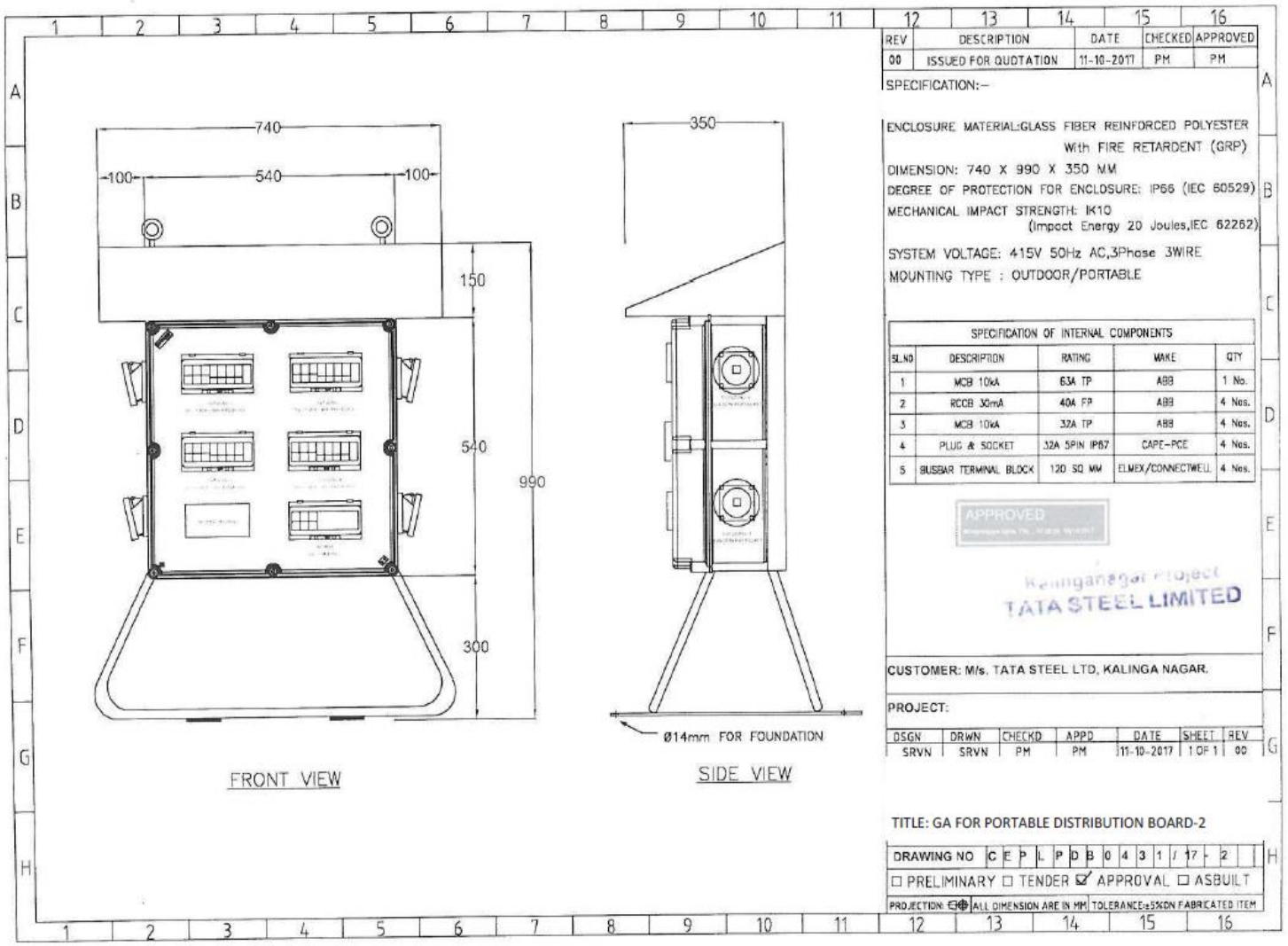


Fig. 9.1 Layout of a modern Power Distribution Board

x. General Electrical Safety

i. In general, equipment or machinery being moved or transported must maintain minimum clearances of 25 ft. to all power lines.

ii. TAG IN/ TAG OUT must be in force in Switch Room and all Distribution Boxes for live power line. The authorized person's name and contact no shall be displayed

iii. Ensure "double insulated" three - core cables and three pin connectors are used and are properly ground "all insulated" types, all electrical tools and appliances must be manufactured for industrial use.

iv. All connections shall be electrically and mechanically sound and properly insulated. Taped joints are not permitted. Connections to socket outlets must be made with proper plugs (industrial top and socket).

v. Splices in electrical cords are not permitted. Repairs must be made at the socket connection and retain the same mechanical and dielectric condition of the original connection.

vi. Damaged or defective electric tools, equipment and extension cords, etc. must not be used and shall be tagged out of service, removed from the work area and taken back to stores.

vii. Only licensed electricians are authorized to repair and work on electrical equipment. Tampering with electric tools or equipment by others could result in termination.

viii. Temporary electric cabling should be elevated 2.2 meters above the floor/ground or covered for protection. It must be kept clear of walkways and other locations where it may be exposed to damage or create a tripping hazard.

ix. Energized wiring in junction boxes, circuit breaker panels and similar places must be covered and locked at all times.

x. Areas with live high voltage wires or terminals must be barricaded against entry and warning signs posted Danger – High Voltage and Authorized Personnel Only.

xi. Personnel should never work on energized equipment, de-energizing (lockout/tag out) the equipment is always the first requirement.

xii. The lockout and tag out procedure will be used when testing or working on, or around, energized installation.

xiii. Working around energized equipment should never be done alone. A second electrician must always be available for assistance.

xiv. If lockout/tag out of the work is infeasible (must be demonstrated), work on energized electrical circuits must be approved by the Site In-charge. All safety precautions necessary must be taken, PPE use must be evaluated per the exposure and used, i.e high/low voltage gloves, insulated shoes, overcoats/aprons, face shields, and other protective equipment like insulated tools, blankets, mats, etc. must be used.

xv. The welding machines earth leads shall be properly fixed without loose contacts. The earth cable only has to be used. No steel members shall be used as earth leads.

xvi. Electrical crews must be qualified for the equipment and tools they work on, including being trained in Cardio-Pulmonary Resuscitation (CPR) methods and First Aid for rendering help in the event of electric shock.

y. Qualified Persons for Electrical Works

(One who is trained and wiremen licensed to Govt. of Respective State and familiar with the construction, operation and safety hazards of the equipment upon which they are permitted to work.)

i. Qualified persons are intended to be only those who are well acquainted/experienced with and thoroughly conversant in the electric equipment and electrical hazards involved with work being performed.

ii. Only qualified persons may be permitted to work on or near exposed energized parts. Such persons are required to have been trained in three specific areas:

iii. Qualified persons must be capable of working safely on energized circuits;

iv. Must be familiar with the proper use of special precautionary techniques and procedures bases on equipment and exposure; and

v. Must be familiar with required personal protective equipment, insulating and shielding materials, and insulated tools.

vi. Qualified persons are expected to be able to evaluate unknown situations and adjust their activities in such a way that only safe work practices are used. Such behavior is the responsibility of the qualified person.

vii. It is possible and likely for an individual to be 'qualified' with regard to certain equipment in the work place, and unqualified on other equipment they must know their limitation and stop work if not qualified on what equipment they were to work on.

viii. An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. The process must be documented as proof.

z. Mandatory PPEs of electrical work on LV & HV

i. HV arc flash suit with protective hood (for protection of face and head) as specified for hazard risk category-4 in NFPA-70E or similar IS specification for working on HT switch gear (for all voltage >690 V) to the concerned licensed electrician or competent person.

ii. LV arc flash jacket/FR as specified for hazard risk category-4 in NFPA-70E or similar IS specification having ATPV rating of 8.5 to 9 cal/cm2 for working on LV (>260V and <=690V) to the concerned licensed electrician or competent person.





iii. The LV arc flash jacket as shown above shall be worn continuously while working on LV (>260V and <=690V). The color specification of LV arc flash jacket should be blue.

iv. Electrical hand gloves should have following specification: Flame resistance, arc flash and cut protection of voltage rating (>260V and <=690V).

v. Electrical safety over shoe of relevant IS make for foot protection of licensed electrician or competent person while working in HV & LV line or equipment.

9. USE OF HAND TOOLS AND POWER-OPERATED TOOLS

a. General Provisions

i. All hands and power tools and similar equipment, shall be maintained in safe condition.

ii. When power operated tools are designed to accommodate guards, they shall be equipped

iii. with such guards, when in use;

iv. Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains and other reciprocating, rotating or moving parts of the equipment shall be similarly guarded;

v. Personnel using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazards;

vi. All hand-held powered platen sanders, grinders, grinders with wheels of 5 cm or less, routers, planers, laminate trimmers, nibblers, shears, scroll saws and jigsaws with blade shanks of 0.5 cm wide or less shall be equipped with only a positive on-off control.

vii. All hand-held powered drills, tappers, fastener drivers, horizontal, vertical or angle grinders with wheels greater than 5 cm in diameter, disc sanders, belt sanders, reciprocating saws, saber saws and other operating powered tools shall be equipped with a momentary contact on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

b. Hand Tools

i. The subcontractor shall not issue or permit the use of unsafe hand tools;

ii. Wrenches including adjustable pipe end and socket wrenches shall not be used when saws are sprung to the point that slippage occurs;

iii. Impact tools such as drift pins, wedges and chisels shall be kept free of mushroomed heads;

iv. The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight on the tools.

c. Power Operated Tools

i. Electric power operated tools shall be either of the approved double-insulated type or shall be grounded;

ii. The use of electric cords for hoisting or lowering loads shall not be permitted;

iii. Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming incidentally disconnected;

iv. Safety clips or retainers shall be securely installed or maintained on pneumatic impact (percussion) tools to prevent attachments from being incidentally expelled;

v. All pneumatically riveting machine staplers and other similar equipment provided with automatic fastener feed, which operate at more than 7 kg/cm2 pressure at the tool a safety device on the muzzle to prevent the tool from ejecting the fasteners unless the muzzle is in contact with the work surface;

vi. Compressed air shall not be used for cleaning purposes except when the pressure is reduced to less than 2 kg/cm2 and that too with effective chip guarding. The 2 kg/cm2 pressure requirement does not apply to concrete form, mill scale and similar cleaning purposes;

vii. The manufacturer's safe operating for hoses, pipes, valves, filters and other fittings shall not be exceeded;

viii. Only personnel who has been trained in the operation of the particular tool shall be allowed to operate power-actuated tools;

ix. The tool shall be tested each day before loading to see that the safety devices are in proper working condition. The method of testing shall be accordance with the manufacturer's recommended procedure;

x. Any tool found not in proper working order, or that which develops a defect during use, shall be immediately removed from service and not used until properly repaired;

xi. Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any other person. Hands shall be kept clear of the open barrel end;

xii. Loaded tools shall not be left unattended;

xiii. Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tiles, surface hardened steel, glass block, live rock, face brick or hollow tiles;

xiv. Driving into materials that can be easily penetrated shall be avoided unless backed by a
xv. substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side;
xvi. No fastener shall be driven into a palled area caused by an unsatisfactory fastening;
xvii. Only non-sparking tools shall be used in an explosive or flammable atmosphere;
xviii. All tools shall be used with the correct shield, guard or attachment as recommended by the manufacturer.

d. Abrasive Wheels and Tools

i. All grinding wheel must be ISO certified only.
ii. All grinding machines shall be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operation;
iii. Grinding machines shall be equipped with suitable safety guards;
iv. The maximum angular exposure of the grinding wheel periphery and sides shall not be more than 900, except that when the work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 1200. In either case, the exposure shall begin not more than 8.650 above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the bursting of the wheel;
v. Floor and bench-mounted grinders shall be work-rests, which shall be rigidly supported and readily adjustable. Such work-rests shall be kept at a distance not to exceed 5 mm from the surface of the wheel;
vi. Cup type wheels used for external grinding shall be protected by either revolving cup guard or a band type guard;
vii. When safety guards are required, they shall be mounted as to maintain proper alignment with the wheel and the guard and the guard and its fastening shall be adequate strength to retain the fragments of the wheel in case of incidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 1800;
viii. Portable abrasive wheel used for internal grinding shall be provided with suitable safety flanges;
ix. When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of incidental breakage, shall be used;
x. All abrasive wheels shall be closely inspected and ring tested before mounting to ensure that they are free from cracks or defects;
xi. Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place;
xii. All employees using abrasive wheels shall be protected by suitable eye protection equipment.

e. Wood Working Tools

i. All fixed power-driven woodworking tools shall be provided with a disconnect switch that can either be locked or tagged in the off-position;
ii. The operating speed shall be attached or otherwise permanently marked on all circular saws over 0.5 m in diameter or operating at over 3000 peripheral rpm. Any saw so marked shall not be operated at a speed other than that marked on the blade. When a marked saw is re-tensioned for a different speed,

the marking shall be corrected to show the new speed;

iii. Automatic feeding devices shall be installed on machines wherever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points;

iv. All portable power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position.

10. START UP, COMMISSIONING AND TESTING:

There are various activities involved prior to commissioning- the major ones are -Hydraulic Test, Steam Blowing, Transformers Charging, Boiler Light Up, Rolling and Synchronisation and Full loading of unit.

a. These activities shall be personally supervised by the site executive along with the commissioning engineer.
b. Appropriate Work Permits shall be taken as applicable
c. The readiness of upstream and downstream system shall be ensured before taking up.
d. These shall be handled strictly by the authorized persons only and the team shall be suitably briefed about the activity including hazards & risks involved and control plan by the concerned executive-in-charge before start.
e. Entry of persons to the area of activity shall be suitably restricted and the emergency functions like Ambulance, first aid center and Fire station shall be intimated about the plan well in advance.
f. Tag-in/ Tag-out shall be in place while charging transformer and whenever necessary.
g. Electricians with valid wiremen license only shall be permitted to work on power lines.
h. The area and the passage shall be adequately illuminated.

11. FIRE SAFETY

a. The Fire Prevention, Protection and Preparedness Program is an integral part of the overall HSE Program. Effort and consideration must be given to safety, life and potential for delays in construction schedules and plant startup, as well as protection of property on a given project. The purpose of which is to prevent
    i. Inception of fire
    ii. Loss of life or personal injury
    iii. Loss of Property
    iv. Interruption of operations
b. Site-in-charge / Safety Officer will make periodical review of the site Fire Protection, Prevention Preparedness Programme, Site conditions and available fire protection equipment. It is very imperative that the Sub-contractors along with BHEL to establish good contact with Local fire station for availability of Fire tender in case of emergencies, in additional to their own fire equipment.
c. Fire Protection, Prevention and Preparedness Inspections - The Contractor /Sub-Contractor will be required to make frequent fire prevention inspections of his work site and operating facilities.
   Deficiencies will be corrected at once.
d. Area where Hot work activities are carried out (Gas cutting / Welding/ any other spark producing work)

above a working spot, a GI / fire-resistant non-asbestos sheet or suitable material shall be placed to prevent the fall of hot sparks. A bucket of water shall be kept nearby while doing hot work

e. Hot work shall be preferably carried out in a designated area with a standing Hot Work Permit, to be renewed monthly. The designated area shall have fire extinguishers.

f. Any hot work outside designated area shall require a Hot Work permit and fire watch. No flammable material shall be stored within 35 feet from any fire load.

12. PAINTING:

a. Requirements provide a detailed procedure to be implemented by all concerned employees and sub-contractors involved in painting activities.

b. Significant Environmental Hazards:

i. Chemical hazard due to inhalation of lead fumes (lead containing paint)

ii. Chemical hazard due to inhalation of VOC's from paining operations

iii. VOC's from painting and coating operation

iv. Disposal of paints and coats drums

c. Control Procedure for Paining:

i. Chemical products used in painting and coating operation shall have proper MSDS sheet in place. Whenever any doubt arises with respect to handling and safety point of view it should be accessed to all concerned.

ii. Toxic substances and hazards relate the toxic chemicals shall be identified.

iii. Proper PPE shall be used including plastic gloves appropriate overall etc.,

iv. Arrangement for cleaning of spillage shall be ensured

d. Only trained workers shall be allowed and proper training should be imparted to the works.

e. Exposure limits of the toxic substances shall be checked before starting the work and nobody shall be allowed to carry the work beyond the permissible limit.

f. Ventilation or exhaust facility shall be provided at place where painting and coating operations are carried out.

g. Overalls shall be supplied by the contractors/subcontractors to the workmen and adequate facilities shall be provided to enable the painters to wash at the cessation of work.

h. Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored.

i. A caution board in national /regional language "**smoking strictly prohibited**" shall be displayed in the vicinity.

j. Suitable fire extinguishers/sand buckets shall be kept available at places where flammable paints are stored, handled or used.

k. In case of indoor painting or painting in confined spaces, exhaust ventilating shall be provided. If adequate ventilation is not provided a proper respirator shall be provided and used by persons who are trained and fit tested.

l. The VOC's from painting and coating operations shall not exceed the permissible level of CPCB/ SPCB norms. The paints and coats must be selected as per the guidelines.

m. Workers shall thoroughly wash their hands and feet before leaving the work.

13. "HAZARDOUS ENERGY" CONTROL PROCEDURE/ LOCKOUT/TAGOUT (LOTO)

Hazardous Energy Control Procedures, known as "Lockout/Tagout (LOTO)" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

Contractors must develop and submit a written LOTO program This requires that a designated qualified individual turns off and disconnects the machinery or equipment from its energy source(s) before performing service or maintenance and that the authorized employee(s) either lock and tag the energy- isolating device(s) to prevent the release of hazardous energy and test the machine or equipment to verify that the energy has been isolated effectively.

a. Minimum Requirements:

The following are minimum requirements that must be included in the Contractor's LOTO program:

i. Inspection of equipment by a trained individual who is thoroughly familiar with the equipment operation and associated hazards.
ii. Identification and labeling of lockout devices. Purchase of locks, tags, and blocks Development of a standard written operating procedure, permitted through a controlling authority that is followed by all workers.

b. General Requirements

The following steps must be taken to protect workers that install or service equipment and systems:

Follow the hazardous energy procedures and statutory regulations. Follow the manufacturer's service/repair instructions. Identify and label all sources of hazardous energy. Before beginning work, accomplish the following:

i. De-energize all sources of hazardous energy:
ii. Disconnect or shut down engines or motors.
iii. De-energize electrical circuits.
iv. Block fluid (gas or liquid) flow in hydraulic or pneumatic systems.
v. Block or secure machine parts against motion.
vi. Block or dissipate stored energy.
vii. Discharge capacitors.
viii. Release or block springs that are under compression or tension.
ix. Vent fluids from pressure vessels, tanks, or accumulators—but never vent toxic, flammable, or explosive substances directly into the atmosphere

c. Lockout and tag out all forms of hazardous energy including electrical breaker panels, control valves, etc. Make sure that only one key exists for each of your assigned locks and that access to the key is controlled. Verify by test and/or observation that all energy sources are de- energized.

d. After completion of the work, accomplish the following:

i. Inspect repair work before removing the lock and activating the equipment.
ii. Make sure that only the worker that installed the lock removes his/her assigned lock.
iii. Make sure that all workers are clear of danger points before re-energizing the system.

e. LOTO Procedure

PURPOSE AND SUMMARY

This procedure provides the requirements and responsibilities of Hazardous Energy Control and the process for Lockout / Tag out (LOTO) of energy isolating devices (valves, circuit breakers, disconnect, etc.). Its use

shall ensure that machinery, equipment, or systems are isolated from all potentially hazardous energy to prevent unexpected energization, startup, or release of stored energy which may cause personnel injury or property damage.

This procedure applies to all BHEL personnel and subcontractors working on the WBPDCL (1X660MW) STAGE-III projects where equipment must be taken out of service for the performance of work activities such as installation, maintenance, repair, construction, or equipment removal. The procedure may also be used to isolate equipment of which the energization or operation may present danger to personnel or property.

Lockout / tag out are not required for electrical equipment that can be unplugged from the source and the person performing the work has control of the plug.

This procedure shall be applied to prevent injury or damage caused by the unexpected release of active or stored energy. Hazardous energy sources could be in the form of the following:

- Electrical
- Hydraulic
- Chemical
- Thermal
- Mechanical
- Pneumatic

Preplanning of work activities includes the identification of all potential hazardous energy sources so that they may be properly controlled and isolated, locked, and tagged out.

Prior to initiating work activities on or around locked out / tagged out equipment, the equipment must be tested and tried by or in the presence of the person(s) performing the work activities.

RESPONSIBILITIES

- The Engineers in Charge is responsible for implementing and enforcing this procedure and approving lockouts /tag outs that impact the operation of the project.
- The Engineer in Charges responsible for authorizing Lockout /Tag out Requests.
- The Lockout / Tag out Coordinator is responsible for maintaining the Lockout / Tag out Log. Each shift should have a designated Lockout / Tag out Coordinator.
- The Isolator is responsible for determining the proper isolation devices and device positions required to isolate all potential energy sources so that the work stated on the Lockout /Tag out Request Permit may be safely performed. The Isolator must be familiar with the equipment and energy type(s) that require isolation. For this reason, in some cases the Isolator may be more than one person (i.e. Engineer, System Operator and/or Electrician). The Isolator shall position the specified device points, and apply locks and tags, and sign the tags and the LOTO Permit isolation point blocks.
- The Safety Manager is responsible for conducting an annual audit that is documented to ensure all procedures and requirements are current and being followed as written.

DEFINITIONS

Affected Employee: -

An employee whose job requires him/her to operate or use machinery or equipment on which servicing or maintenance is being performed under a lock out/tag out procedure or whose job requires him/her to work in an area in which servicing or maintenance is being performed under a lockout/tag out procedure

Authorized Employee: -

An employee who implements a lockout/tag out procedure on machinery, equipment, or systems in order that servicing or maintenance may be performed. Often an authorized employee and an affected employee may be the same person.

Danger "Do Not Operate" Tag

A tag used to identify energy isolation devices and specify the required position of the device. The tag should be affixed to the isolation device such that it is in plain view of anyone attempting to operate the device. The tags shall be sequentially numbered and shall specify the lockout/ tag out request number. The tag shall also state the purpose, and the expected duration of the lockout /tag out

Isolation Device

A device that is designed and intended to prevent the passage of energy. These devices, usually located at the energy source, are typically valves, circuit breakers, etc. Isolation devices should have a means of being locked in position

Lockout Device

A device that uses a positive physical means such as a lock, either key or combination type to maintain an energy isolation device in the safe position and prevent the in advertent energization of machinery, equipment, or systems. Device locks should serve no other purpose other than hazardous energy control isolation

Lockout Tag out Request Permit

A pre-numbered form used to request that machinery, equipment or systems be taken out of service. A Lockout/Tagout Request Permit may be initiated by any one requiring energy isolation for work activities or for taking faulty equipment out of service

Lockout / Tag out Request Log

A record of all Lockout /Tag out Request Permits shall be maintained by the Lockout /Tag out Coordinator.

PROCEDURE

1. REQUESTING A LOCKOUT / TAGOUT PERMIT

When machinery, equipment, or systems are partially or completely taken out of service for work activities or equipment protection, a lockout / tag out shall be requested. The requestor shall be familiar with scope of work required and shall provide a brief description of the work on the Lockout / Tag out Request Permit. The requestor shall also provide the proposed start time and estimated duration of lockout / tag out. If familiar with the machinery, equipment, or system to be taken out of service, the requestor may identify the devices that are required to be isolated. The LOTO Request Permit shall be forwarded to the Authorized Lockout / Tag out Coordinator for reviewed and signature, along with Permit to Work number to be entered on the LOTO Request Permit.

a. The Lockout / Tag out Coordinator shall record the necessary information on the Lockout / Tag out Request Log and forward the request to the Engineer in Charge for approval.
b. The Safety Manager or Engineer in Charge shall review the Lockout / Tagout Request Permit for impact on project operations. Project operations could be impacted by the equipment being taken out of service or by the required isolation to take the equipment out of service. If project operations are impacted by the Lockout / Tagout, the request shall be forwarded to the Engineer in Charge for approval.
c. The Engineer in Charge shall provide the lockout / tag out isolation points necessary to perform the task stated on the request. The device identification, device location, device position, and locking mechanism

shall be entered into the appropriate blocks on the Lockout / Tag out Request Permit.

d. The Engineer in Charge indicates approval of the Lockout / Tagout Request Permit by signing in the appropriate space on the request. If the Lockout /Tag out Request Permit is rejected, the Engineer in Charge shall return it to the requestor, via the Lockout / Tagout Coordinator with a written explanation of the rejection.

e. Once approved, the Lockout / Tag out Request Permit shall be forwarded to the Lockout / Tag out Coordinator to assign tags and locks.

f. The log shall show current status of all Lockout / Tag out Request Permits from submittal to approval, through lifting of locks and tags to final closeout. The log shall be maintained by the Lockout / Tag out Coordinator in their office.

2. PLACEMENT OF LOCKS AND TAGS

a. The tags shall be filled out to match the information on the LOTO Request Permit. Appropriate locks for the types of isolation devices specified shall be collected and placed with the tags and the Lockout / Tag out Request Permit.

b. The isolator(s) shall take the device locks, tags, and the Lockout / Tagout Request Permit to position the specified isolation devices, sign and hang the tags, and place the locks. If the isolator does not agree with or understand the Lockout / Tagout Request Permit, or has a problem performing the isolation, the problem should be brought to the attention of the Safety Representative or Area Supervisor immediately and the lockout / tag out should be postponed until the situation is resolved.

c. Once the Isolator has placed all “locks” on isolation points, they will “test ”and “try” the machinery, equipment, or system to ensure all hazardous energy has been completely removed and the isolation is one totally accomplished, and has initialed and signed the Lockout /Tag out Request Permit indicating all isolation points have been confirmed. Examples of “lock”, “test” and “try”:

- by checking that all locks on the LOTO Request Permit have been applied and are in the specified position open/closed, on/off, etc.; metering test of electrical circuits, opening of drain valves, checking pressure gauges or indicators; and try by pushing start buttons and on/off switches, etc.
- Testing shall be performed by person(s) knowledgeable of the energy source(s) being isolated (e.g., an electrician should meter electrical circuits).

d. A copy of the completed Lockout /Tag out Request Permit shall remain with the Work Package and used as part of the daily Pre-Job Briefings

3. WORKING UNDER A LOCKOUT / TAGOUT REQUEST

a. Prior to starting the work activity, the person(s) performing the work shall review the Lockout / Tag out Request Permit and place the necessary tags and personal locks on the identified isolation devices. Personal locks may be placed only on devices that have already been locked and tagged in accordance with the Lockout / Tag out Request Permit.

- All personal locks shall be accompanied by a tag that is signed and dated by the worker(s) and specifies the work activity being performed.
- Personal locks should be of a different color than device locks for ready identification.

b. Verification of the effectiveness of the isolation by the Isolator shall be performed for Worker’s working under the lockout / tag out, by demonstrating the checks on “lock”, “test” and “try”,

c. When the work activity is finished, personal locks and tags shall be removed and the Safety Representative

shall be notified that the Lockout / Tagout is no longer required. If work under a lockout / tag out is to be delayed or interrupted for a period in excess of 24 hours, personal locks shall be removed until the work restarts. Personal locks shall be removed prior to the worker(s) leaving the project at the end of shift unless the key(s) are maintained at the project.

4. REMOVAL OF LOCKS AND TAGS

a. When the lockout / tag out is no longer required, the Safety Representative or Area Supervisor shall obtain the Lockout / Tagout Request Permit from the work package for LOTO removal. Prior to removing locks or tags that may allow equipment to be energized, a check shall be made to verify that the equipment is free to safely operate (i.e., will not cause damage or injury). The locks and tags shall be removed and returned to the Lockout / Tagout Coordinator. Isolation devices may be repositioned at the discretion of the Engineer in Charge according to operational requirements. The Isolator shall complete the Lockout / Tagout Request Permit indicating each lock and tag has been removed and the Safety Representative or Area Supervisor forward to the Lockout / Tagout Coordinator.

b. The Lockout / Tagout Coordinator shall discard the tags and maintain the completed Lockout / Tagout Request Permit for future reference.

c. In the event that an employee leaves the job site without removing the personal lock I tag, the following measures shall be taken and documented. The measures listed below are a minimum set of guidelines and under all circumstances, refer to the site-specific safe work plan for detailed procedures:

- Attempt calling / contacting the employee to return to the site for removal.
- In the event an employee cannot be contacted, the Site Manager and Safety Manager shall sign an Emergency Lockout/Tagout Removal Form, which has been completed by the Area Supervisor.
- Employee shall be notified upon returning to the site, prior to beginning any work.

5. INTERRUPTION OF A LOCKOUT / TAGOUT

Operational Emergency

The Engineer in Charge / Safety Manager /Area Supervisor may deem it necessary to temporarily remove the locks and tags from isolation devices, prior to the end of the work activity. The standard procedure for removal of locks and tags shall be followed. Extreme caution shall be taken by the Isolator removing the locks and tags to prevent personnel injury.

Testing

When the performance of a work activity requires the functional testing of a machine, component, or system, the locks and tags may be temporarily removed in accordance with the tag removal, to perform the test. As a result of the testing, if it is determined that the equipment needs further work, the locks and tags shall be positioned back on to the device. If it is not necessary to replace all the locks and tags, then the unnecessary locks and tags may be returned to the Lockout / Tagout Coordinator. The Engineer in Charge shall initial the Lockout / Tag out Request Permit in the removal block to indicate that these locks and tags have been removed. When testing has been satisfactorily completed, the locks and tags shall be removed.

ISOLATION DEVICES

- In most industrial applications, there are isolation devices that were not designed to accommodate a locking device. In these instances, an acceptable alternative that physically obstructs or prevents the use of the isolation device shall be found. Chains shall be placed on valves or electrical panels. Wires shall be determinate, pulled back, taped, and secured.

- If an isolation device does not accept a lock, a tag only is acceptable; however, all possible precautions shall be undertaken to provide a level of safety for the workers. The tag shall be readily visible to anyone attempting to operate the device.
- If more than one Lockout / Tagout Request Permit requires that a single isolation device be locked and tagged, a lock and tag for each request shall be placed. Each lock in itself prevents the inadvertent operation of the device.

GROUP / COMPLEX LOCKOUT

In a multiple lockout / tag out procedure, each person working on the machinery or equipment must place a lock or tag on the energy isolating device. If the energy isolating device will not accept multiple locks or tags, a hasp (a multiple lockout device, may be used. The locks or tags must be placed in such a way that energy cannot be restored to the machinery or equipment until every lock or tag is removed. As each employee involved no longer needs to maintain lockout / tag out protection that employee removes his - her lock and/or tag. The employee attaching the lock or tag is the only person authorized to remove the lock or tag.

6. TRAINING

The training must include recognition of hazardous energy source, type and magnitude of energy available, methods and means necessary for energy isolation and control. Each authorized employee shall receive adequate training. The training should address that all affected employees are instructed in the purpose and use of the energy control procedure. There should be training provisions included for any other employee whose work operations are or may be in an area where energy control procedures may be utilized. The employee training should also address when tag out systems are used including the limitations of a tag (tags are warning devices and do not provide physical restraint). The training should also include that a tag is not to be removed without authorization. The tag is never to be ignored or defeated in any way. Retraining is required when there is a change in job assignments, in machines, a change in the energy control procedures, or a new hazard is introduced. All training and I or retraining must be documented with employee's name and dates of training.

7. PROGRAM REVIEW

The lockout / tag out program must be reviewed at least annually. The review must ensure that procedures are being followed and that they are effective. A documented review of the inspection must include the date, the equipment, employees involved & the inspector. The inspector must be someone other than those actually using the lockout / tag out in progress.

ATTACHMENTS

#1. Danger (DO NOT OPERATE) Tags



#2. Device & Personal Locks and Multi Lock Hasp:



#3. Lockout / Tagout Request Permit

BHEL	**LOCKOUT / TAGOUT REQUEST PERMIT**	LOTO Request Permit No.:
		Work Permit No.:
Equip. Out of Service:	LOTO Date Required by: _____/_____/_____	Estimated Duration:
		LOTO Requested Date:
Scope of Work:		**LOTO Authorization** Signed by:
		Date:
		LOTO Removal Authorization Signed by:
		Date: Time:

Tag No.	Device to be Tagged / Locked I.D. No.	Device Location	Device Position *OPEN / CLOSED* -	Lock No.	Tag/Lock Placed by Print/Sign - Date/Time		Tag /Lock Removed by Print/Sign - Date/Time	

Comments Instructions: **Attachment 3.Lockout / Tag out Request Permit:**

#4. Lockout / Tag out Request Log

LOTO Permit No.	**Requestor Name**	**Equipment & Location**	**Est. Work Completed Date**	**Approval Date**	**LOTO Placed Date**	**LOTO Removed Date**	**Comments**

14. RISK ASSESSMENT

Risk and Hazard Analysis

In order to produce an overall Project EHS Plan, a project must be assessed for its risks. There are two components to the risk and hazard analysis. The procedure used to examine and plan for the identified risks and hazards is called a General Hazard and Risk Assessment.

JSA/HIRA review

Prior to commence the following activities Method statement and JSA/HIRA to be prepared by the concern engineer in coordination with EHS officer and submit to the client for review and approval. After getting approval the work will be started under PTW after clearance. For HIRA and criteria for the defining the high, medium & low risk the relevant annexure be referred. In case any deviations required in the approved method statement the concerned engineer/supervisor has to prepare additional HIRA/JSA to cover the new activities and associated risk. Following activities to be covered,

- Deep excavation (more than 5 feet)
- Significant concrete pouring (like heavy foundation, TG deck, Slab casting etc.)
- Confined entry
- Blasting
- Working on electrical/ energized equipment's
- Steel erection more than 5-Ton weight
- Working at height prior to completion of stairs/ladders/hand railing etc.

Definition:

HAZARD - Any potential or present danger to persons or property within the project site, e.g., oil on the floor is a hazard.

INCIDENT - An unintended happening that may result in injury, loss or damage, e.g., Slipping on the oil is an Incident.

INJURY – Physical harm, the result of an Incident, e.g., a sprained wrist from the fall would be an injury.

Hazard Analysis Document

- For high risk and dangerous work identified, the Applicant shall complete and submit a Hazard Analysis Document together with the PTW request. It will be a JSA (Job Safety Analysis) or Preliminary Hazard Analysis Checklist. And it shall be reviewed and approved by respective Construction and HSE Representatives.
- Issues such as work interface, coordination, drawings, toolbox meetings and work type/duration shall be detailed and included with supporting documentation for the Applicant's request for PTW.
- If applicable, Hazard Analysis Document shall be used as the foundation for development of Safe Work Method Statement. Each hazard identified shall be addressed in the Safe Work Method Statement and be submitted as part of the Applicant's submittal package.

Evaluation of Sub-contractor Risk Assessments includes

- Experience and expertise in performing similar type work.
- Duration of work performed
- Location of the work to be performed.

- Nature of the work to be performed.
- Potential for a subcontractor performing the work to expose themselves, other persons or employees, to hazards.
- Potential for exposure to work site hazards.

Review of Subcontractor specific issues

Preventive and protective measures must be introduced according to the following order of priority

- Eliminating the hazard by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc.
- Controlling the hazard at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc.
- Minimizing the hazard through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- Providing appropriate personal protective equipment (PPE) in conjunction with training, use, and maintenance of the PPE.

15. HSE PREPAREDNESS FOR ADVERSE CLIMATES AND WEATHER

All Preventive and Precautionary measures to ensure Health & Safety of workers in all possible adverse weather conditions based on the analysis of the local area conditions to be taken by the subcontractor

15.1 SUMMER

1. The Working Time and Lunch Hour will be as per instruction of Statutory Authorities (no work between 11am to 3:30pm). However, in case temp comes down due to rain/cloudy weather work will continue as per normal routine.
2. During long lunch break, worker will be allowed to go back home for rest. Those who will like to stay back will avail at the facility of rest shed or other designed area.
3. They will be allowed to take small break during work as per their need.
4. Water sprinkling will be done on roads to reduce dust concentration.
5. Workers will be provided with adequate cool drinking water and Butter milk/Lemon water etc.
6. Adequate ORS stock will be made available at the work location in the First-Aid Box for use as needed and at First-aid Centre for emergency need.
7. Fire prevention shall be on high alert, with removal of dry grass and bushes, etc, inside and outside the surrounding work areas. No smoking, and control of open flame/sparks shall be maintained and monitored.
8. Worker will be informed about the Do's and Don'ts to be followed during summer in the Pre Job Brief.

Dos & Don'ts

1. Drink plenty of cool water and other non-alcoholic fluid and keep body well hydrated.
2. Eat salt in food to replenish loss of salt through sweating.
3. Avoid over physical exercise.
4. Have adequate sleep at night.
5. Eat light and less spicy food
6. Avoid eating food which was cooked long time ago.

7. Nobody should use small water bodies such as pits, running rain water through crevices etc. for drinking and cleaning purpose as it may be unhygienic.

Emergency Handling

In case of emergency due to heat disorder:

1. Rescue the victim from workplace and place under shed.
2. If to be rescued from height, use stoke basket or rescue kit.
3. Inform Ambulance immediately.
4. If nearby any air conditioned room/shed is available, place him inside the room/shed.
5. Administer First aid by trained First aider for Heat Disorder
6. If conscious, give him ORS solution to drink.
7. If required send the victim hospital immediately.

15.2 MONSOON

A. Height Work & Structural Safety:

1. Ensure that all height work platforms are barricaded and avoid any highly hazardous
2. Height work.
3. Ensure that all personnel have good quality and intact safety shoes
4. Stop all dangerous height work during rain
5. Explain Do's and Don'ts to workers during Tool Box Meetings
6. Ensure that there are no weak structures, boards etc. that can fall during high winds
7. Do not allow any loose material (e.g. GI sheet, Ply board, empty cement bag, aluminium foil, foam sheets etc.) on roof sheds or top of structures.
8. Do not permit any one to ride up or come down scaffolds frame work during heavy wind or rain.
9. Provide "anchor" of adequate strength to scaffolds and other high-rise structures.
10. All rest sheds and GI sheds will be anchored into the round and wall and roof panels will be secured with J hook to prevent shed from blowing over or parts/pieces becoming airborne. Proper earthing per IS standard is also to be installed.
11. Do not go alone nor permit anyone to stay at tower-tops, roof-tops, high structures or on electrical poles during the course of stormy weather or heavy rain.

B. Electrical:

1. All electrical connections / loads have to be routed through ELCB / RCCB (residual current circuit breaker) whose rating should be 30mA.
2. RCCB operational checks need to be done DAILY / WEEKLY during monsoon season.
3. Avoid joints on power cables which need to be laid over-head or under-ground, better not to have any joint at all. In case joints become essential, such cables must be housed rigidly and insulation must be provided as per approved standard. The joint shall be suitable for outdoor use.
4. All electrical distribution board shall be properly covered at top and sides to protect from rain water. Extension boards shall be protected from rain water.
5. Ensure proper "earthing" for each and every electrical appliance.
6. Double earthing need to be provided for 3-phase power supply and for voltage more than 220V.

7. Provide lightening arrestors at the top of Boiler 3 and boiler 4 and rest sheds which are not covered by existing lightening arrestor of other installation.

C. Others:

1. Maintain smooth flow on open drains. i.e. no obstruction or blockade shall be made on storm water drains. If required, make temporary drains.
2. Arrange back-filling of excavated pits on war-footing basis.
3. Arrange bringing down booms of all cranes, hydra machines during stormy weather (wind speed 40-50 km/hr)
4. Confirm that all gantry cranes are effectively choked to prevent rolling and toppling.
5. Do not forget to deep ready a dew battery operated lights at site-offices during rainy season.
6. Avoid using wet damp clothes.
7. Hard Barricade excavated zone filled with water with scaffolding pipe & clamp with reflective net
8. Engage diesel operated water pump to dewater work area. For electrically operated water pump, the starter shall be protected from rain water. All rotating parts shall be guarded. Ensure availability of sufficient water pumps.

D. Health and hygiene:

1. Monsoon reduces the immunity of our body and makes us vulnerable to many diseases which are commonly associated with this season. It is time for us to keep our body challenging against disease by boosting our immunity and taking safety measures against these diseases.
2. The diseases associated with monsoon are Malaria, Jaundice, Gastro-intestinal infections, like typhoid, cholera etc. apart from these viral infections like cold and cough also make their presence felt. Majority of above said diseases are on account of:
3. Puddle of water formed due to rain become breeding grounds for mosquitoes which spread disease like, malaria and dengue fever. As a precautionary measure against mosquito-bite disease one can use mosquito net around the end which is better choice to mosquito repellents like mats and coils.
4. Pollution of drinking water during monsoon is very common. It is very necessary to drink clean and pure water when water-borne monsoon diseases like diarrhoea and gastro-intestinal infections threaten us.
5. Walking in dirty water during rainy season leads of numerous fungal infection which affect toes and nails. Diabetic patients have to take a special care about their feet. Keeping feet always dry and clean is very necessary. Avoid walking in dirty water. Keep shoes socks and raincoats dry and clean.

E. Workmen will be made aware of following Do’s and Don’ts:

1. Do not sleep in daytime.
2. Avoid over physical exertion.
3. During lightning and thunder storm, do not take shelter under tree. Take shelter inside rest shed or store room.
4. Wash vegetables with clean water and steam them well to kill germs.
5. Avoid eating un-cooked foods and salads should be washed properly before consumption.
6. Drink plenty of water and keep body well-hydrated.
7. Always keep the surrounding area dry and clean. Don’t allow to get water accumulated around.
8. Keep body warm as viruses attack immediately when body temperature goes down.

9. Do not enter air conditioned room with wet hair and damp cloths.
10. Dry your feet and webs with soft dry cloth whenever they are wet.
11. Eat light and less spicy food.
12. Avoid eating food which was cooked long time ago.
13. Eat salt in food to replenish loss of salt through sweating.

15.3 EMERGENCY WEATHER CONDITIONS

Cyclone/Severe thunder storm

In the event of Cyclone/Severe thunder storm, alert will be issued by subcontractor on notification received by Govt. authorities/Metrological departments Customer or BHEL.

The actions required during cyclone/rough weather:

1. Check and advice subcontractors to clean-up work area. Pick up all loose and unused material of respective supervisor's area.
2. Tie to secure all gas cylinders to avoid displacement and unsafe conditions which could be due to wind pressure.
3. Secure portable electricity generating sets and other equipment, pumps, hoses etc.
4. Make preparation for removal of water logging.
5. Take review of work activity and make preparation for removal of equipment and material from vulnerable areas.
6. Isolate/turn off all electrical power form the main panel/switches. Secure and anchor panels properly.
7. Recheck anchorage/tie of all temporary structures/sheds, tall objects, cranes, rigs, scaffolds etc. to avoid toppling due to wind force.
8. Cranes boom shall be secured, either locked or lowered the booms as reasonably and practicably possible and rigs to safe position for the safety point of view.
9. Group up all trash barrels, wooden pallets, forms; wooden decks etc. and anchor properly.
10. Welding machines, air compressors and such equipment are to be grouped together and secured to the stable objects. Welding leads, electrical cables, hoses are to be rolled up and secured properly.
11. Set on site vehicles on high ground in the site area with brakes set firmly.
12. Anchor all tanks, vessels, gas cylinders that may be moved by high wind and water.
13. Evacuate job site.

Personnel Evacuation:

1. Personnel Evacuation will be required if predicted wind speed and storm surge heights are beyond acceptable limits as per the instructions from Govt. Authorities/ Metrological departments or Customer.
2. Once the warning is received for personnel evacuation, an emergency response team shall be formed. The team will work with local authorities and other agencies formed/deployed to evacuate and transport all personnel involved in the project to the cyclone shelter.
3. Cyclone may be followed by the calm "EYE", be aware of it. If the wind suddenly drops, don't assume the cyclone is over. Violent wind may resume from the opposite side direction. Wait for the official "All clear Signal".

4. After the cyclone, do not go outside until officially communicated about safe situation outside. Use recommended routes for returning. Do not panic or rush while returning.
5. Checking of gas leaks and well-being of electrical appliances is essential before leaving the site.
6. Follow local communications for official warning and advice. The construction Manager shall also obtain updates from customer/metrological departments and communicate to the personnel on project site.

15.4 PREVENTION OF COVID-19 (COVID-19 HERE TO BE READ AS COVID-19 AND OTHER PANDEMICS/ COMMUNICABLE DISEASES) AT PROJECT SITE & LABOUR COLONY:

Resumption of Construction Activities after Lock Down and Prevention of Coronavirus Infection during Site Operations and OCP 61A: Prevention of COVID-19 Infection in Labor Colony will be strictly followed.

A. <u>Preventive measures at project site:</u>

- BHEL and Agencies shall nominate COVID Marshalls, who will be responsible for monitoring the COVID prevention measures and apprising management on the same.
- Mandatory health check-up for every worker/ official joining the site
- All activities to be carried out using least amount of paperwork and physical proximity as far as possible.
- ***HSE Observer App*** to be used to monitor HSE Activities and follow up with agencies for closure of non-conformities.

<u>a. Strict Control at the Gate/ Banning Entry to Anyone Not Wearing Masks</u>

i. Security personnel at the gate may erect a barricade preferably approx. 10 meters from the gate and only allow personnel who are wearing proper masks inside.

ii. Public address system may be used to warn any non-compliant visitors

iii. Near entry gate, round markers at minimum 1-meter distance to be ensured so that distancing is ensured

iv. A hand-wash or hand sanitiser facility is preferable at the gate to allow entry after hand wash or hand sanitisation. These are also to be provided at key locations to enable hand wash / hand sanitisation before starting work, before eating, etc.

v. Gutkha, Paan, tobacco etc. to be banned from the site. Spitting to be strictly prohibited.

<u>b. Screening at Gate with Contactless Thermometer & Action on Suspected Cases</u>

i. Security Personnel at the Gate to screen each person entering the premises using a non-contact infrared thermometer, which is duly serial numbered and calibrated.

ii. In case any site worker/ official is found to have fever more than 99 Degrees Fahrenheit or found coughing/ sneezing, he/she may be advised rest till recovery and entry to be permitted after obtaining clearance from medical officer/assistance/attendants.

- Parcel to be collected from gate by concerned person preferably with provision of Special Box
- Any construction material received at site, unless properly sanitized, to be kept undisturbed for at least 3 days and to be used only after that period.
- During Toolbox Talks, minimum 1-meter distance between any two workers to be ensured

<u>c. During site execution activities:</u>

For all site execution activities, social distancing is to be maintained. In case this is not possible due to nature of work, speciality of work, etc, ensure sensitisation of the labour/staff involved and use of appropriate PPEs, especially mandatory face mask. In any case, close working to be allowed only in special

circumstances and ensuring these activities are preferably time staggered to the extent possible

d. In office premises:

i. Sharing of items like pens, water bottles etc. in office premises to be avoided

ii. Doors preferably to be in open condition to avoid contact

iii. All common touch points to be frequently disinfected in a day.

e. Regular disinfection of all Areas, Equipment and facilities

i. A dedicated disinfectant gang to be identified for the task by each agency. The disinfectant gang to be provided full body suits for the task.

ii. All areas (including office premises, site areas, chairs, tables, furniture etc.), tools & equipment to preferably be disinfected by dedicated gang every day before resumption of work.

iv. Common touch points like handrails, lift buttons, door/window knobs or handles, vehicle door handles, taps, conference room & dining hall tables/chairs, common sofas/chairs, visitor sofa/chairs, files & folders, etc to preferably be disinfected regularly at frequent intervals every day.

v. Pool vehicles, to be disinfected after every use. Social distancing to be maintained inside the common pool vehicles as per Govt./ statutory body guidelines.

f. Disinfecting the operator/driver touch points of Vehicles/cranes, T&Ps etc.

Disinfection to also be carried out for all Cranes, Vehicles, Equipment, consoles, T&Ps etc. which come into contact with operating personnel.

g. Posters on COVID-19

Sufficient Posters on COVID-19 to be ensured across the site in languages understood by most workers.

h. Brief guidelines for hand washing are as below:

i. Soap to be provided at each wash basin and replenished regularly.

ii. Washing with soap for at least 20 seconds is recommended.

iii. As a general guideline, for every 100 workers, 1 wash-basin may be provided at site areas.

iv. Close queue to be avoided near wash-basins and 1-meter distance to be maintained. Round markers at 1-meter distance can be ensured as guidance

Composition of Disinfectant:

i. Readily available 1% hypochlorite solution or 4%

ii. Liquid chlorine-1% solution

Iii. Surgical spirit-95% alcohol content

iv. Hand sanitizer should have: Isopropyl alcohol-75%, Gycerol-1.45%, Hydrogen Peroxide-0.125%

B. Prevention of COVID-19 Infection in Labor Colony:

- Spacing of minimum 2 meters between living areas of workers inside a room may be maintained. Preferably, the living area of each worker may be partitioned using sheet of cloth, plastic etc.
- Rooms to be properly ventilated as far as possible
- Sanitation to be given prime importance and personal hygiene to be promoted
- Face masks shall be worn by everyone inside the colony premises
- Spitting of Pan. Gutkha etc. inside the colony and urinating etc. outside the toilets to be strictly avoided
- Regular visits by Doctors to the labor colony can be arranged on non-working day for check-up of all workers
- **Identification of "COVID Wardens" (CWs) by each agency for maintaining the following:**

  i. Keeping an eye on the health of workers and report any suspected cases of fever, coughing etc. to the

management

ii. Keeping an eye on the social distancing measures in the labor colony and report any non-conformances to the management.

iii. Educate the workers about social distancing and COVID prevention measures.

- Training/ Awareness regarding COVID-19 to be provided to workers regularly.
- Workers to be instructed to maintain social distancing of minimum 1 m at all time
- **Posters on COVID-19:** Sufficient Posters on COVID-19 to be ensured across the labor colony in languages understood by most workers.
- All workers to be instructed to inform any suspected cases of illness (individual or others) to an emergency contact number of CW, the emergency contact numbers and CW contact numbers to be displayed at prominent locations
- **Inspection & Review**

  i. Daily Inspection by concerned COVID Wardens and reporting to Agency

  ii. Regular inspection by Agency & BHEL

15.5 Noise Mitigation

High noise is harmful to the human health and it can cause impairment if exposed for long duration at regular intervals, and also cause disruption in nearby communities.

- Noise monitoring shall be carried out in all construction locations periodically.
- Use of silent DG is allowed at site during construction.
- Low noise generation equipment's to be preferred.
- Work areas where noise levels exceed the 85db shall be posted as hearing protection required.
- Use of PPEs / ear plug/ear muff for personnel entering into high noise area.
- Activities generation High noise will be planned in day shift.

Noise Level Chart

Parameter	Night Noise level dBA	Daytime Noise Level dBA
At 1-meter from each piece of equipment	85	85
At Property boundary	70	70

ANNEXURE J

First-Aid Box

Details & Contents of First Aid Box as per Contract Labor (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 labor 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 Labor 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 labor 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 labor 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 K

Vertigo Test

Vertigo Test Procedure/ Guidelines

This document specifies minimum requirements for vertigo test. These may be supplemented by any additional requirements deemed fit by the medical examiner/ HSE department)

Fear of height may be physiological or psychological. Therefore, to rule out any possibility of physiological factor, detailed medical check-up of workers is carried out before vertigo test. Medical check-up of workers includes the following:

history of past illnesses (like epilepsy, drug allergy, diabetics/ hypertension, unconsciousness etc.), general physical examination (like height, weight, BMI, build and nourishment etc.), measurement of pulse rate, Blood Pressure, respiratory rate.

After this check-up, those who are found suitable for height work by examining doctor, are allowed to undergo vertigo test.

During this health check-up, psychology of workers is also studied. If any worker finds it extremely difficult/ frightening to climb the monkey ladder & walk on the beam, during/after performing vertigo test or even before performing, then he is treated as disqualified.

As per standard, during vertigo test, worker is allowed to climb on a foundation through monkey ladder, walk on a beam, then steps down at the other end of beam, through monkey ladder. Height of the beam should be at least six feet from ground level. All necessary safety precautions are taken during this test. Worker has to wear full body harness with double lanyard. A horizontal lifeline is run parallel to the beam and worker has to put his lanyards into the lifeline. Additionally, a safety net is also put below the beam for rescue of the victim in case of a fall from beam.

Following activities are suggested to be carried out during testing:

1. **Walking Bench Training:**
   a. Person should walk over the channel. He should maintain balance & walk without much problem.
   b. If the person has problem to balances himself on repeated chances, he may be having flat foot or some other problem. So, he may not be fit for height work.
2. **Rope Climb Training:**
   Person should be able to climb the rope up to the top channel for ensuring that in case of fall, a person hanging on the safety harness, will be able to safely climb back to the platform within minimum time period before the safety harness start breaking down under the load.
3. **Height Work Training:**
   Person should walk freely on the middle channel while holding the top channel with the help of safety harness.
4. **Ladder for Vertical fall arrestor Training:**
   Vertical fall arrestor rope is fixed from top to bottom of the ladder. It will ensure:
   - Usage of vertical fall arrestor.
   - Usage of two lanyards of a safety harness.
   - Ensure 3-point contact on the ladder while climb.
5. **Chair for work at height Training:**
   - Climb though vertical ladder with two lanyard ropes.
   - Hooking of two lanyard ropes to life line. With this safe arrangement, he can walk to chair.
   - Sits in the chair safely, comes out & walks back to the vertical ladder & come down from vertical ladder. After completion of vertigo test, blood pressure of worker is again measured. If it is not within acceptable limits for any worker, concerned worker is denied height pass.

Only those who pass the above training are to be considered as fit for height work.

CHAPTER -6
T&P HIRE CHARGES

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	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	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

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

NUCLEAR POWER CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)

KAIGA-5&6/40000/PROCUREMENT SPECIFICATION/MS-1

PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND PACKAGE
(ENGINEERING, PROCUREMENT AND CONSTRUCTION)

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PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND PACKAGE
(ENGINEERING, PROCUREMENT AND CONSTRUCTION)

REF. USI NUMBER: 40000

Rev. No. & Date	Description of revision	Revised by Name & Signature	Checked by Name & Signature	Reviewed by Name & Signature	Approved by Name & Signature

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PROCUREMENT SPECIFICATION NUMBER: KAIGA-5&6/40000/PROCUREMENT SPECIFICATION/MS-1,
PROCUREMENT SPECIFICATION
FOR TURBINE ISLAND

VOLUME-II- Section-C, PART-2

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KAIGA-5&6/40000/PROCUREMENT SPECIFICATION/MS-1

REVISION No. – R0, JANUARY-2019

VOLUME-II
Section-C (TECHNICAL REQUIREMENTS)
PART-1

C-1: GENERAL TECHNICAL REQUIREMENTS

1.0 PROJECT INFORMATION

1.1	OWNER / PURCHASER	:	NUCLEAR POWER CORPORATION OF INDIA LTD. (NPCIL)
1.2	ENGINEER	:	EXECUTIVE DIRECTOR (PROCUREMENT)
1.3	Project Title	:	2x700 MWe PHWR – KAIGA-5&6 ATOMIC POWER PROJECT
1.5	Location	:	KAIGA, UTTARA KANNADA DISDRICT, KARNATAKA
1.6	Elevation (RL)	:	RL +32m to +46m
1.7	Nearest Railway Stations	:	KARWAR (Konkan Railway)
1.8	Name of Railway Stations	:	KARWAR (Konkan Railway)
1.9	Ambient Air Temperatures	:	
	a) Maximum dry bulb temperature	:	+41.6 deg C,
	b) Minimum dry bulb temperature	:	10.9 deg C,
	c) Design temperature for electrical equipment / devices	:	+50 deg C
1.10	Relative Humidity		
	a) Maximum during monsoon	:	99.9%
	b) Minimum (design)	:	3%
1.11	Air Quality	:	Air quality is clean and free from chemical pollutants.
1.12	Rainfall	:	
	a) Annual Average	:	3649.31 mm
	b) Highest annual rainfall	:	4695.1 mm in 1988
	c) Lowest annual rainfall	:	2345.3 mm in 2016
	d) Period	:	Year 1987-2017

1.13 Tropicalisation : _____

1.14 a) Wind Pressures :

Height above mean ground level, m	Design Wind Speed m/sec
@ 10 M	5.0
@ 100 M	13.8

The assessment of wind loads based on the above basic wind speed shall be done as specified in IS: 875.

b) Wind direction : Predominantly W,SW,NE & E with respect to true North

1.15 Transport : Rail & Road

1.16 Rail / Road access : About 53 km from Karwar (Konkan Railway) Station and NH 10 passes through Karwar

1.17 SEISMOLOGY : Zone III as per IS1893-2002 part I

1.18 Auxiliary Power : Auxiliary electrical equipment to be supplied against this specification shall be suitable for operation on the following supply systems

a) For AC motors 200 kW and above : 6600 Volts, 3 phase, 50 Hz, non-effectively earthed with following supply variations*

b) For AC motors below 200 kW : 415 V, 3 phase, 3 wire, 50Hz effectively earthed with following supply variations*

c) Construction supply : 415 V, 3 phase, 4 wire, 50 Hz, AC supply effectively earthed, one feeder supplied to the VENDOR at one point, as determined by the PURCHASER near the Sub-station, with

following supply variations *

d)	Panel Lighting fixtures, Space heaters	:	240 V, 1 phase, 2 wire, 50 Hz, AC supply with neutral lead earthed, with following supply variations*
e)	DC motors control and protective devices	:	220 V, 2 wire, unearthed DC supply from Station Battery / Battery Charger, with a supply variation of (-) 20% to (+) 10% of rated voltage.
f)	Instrumentation controls & annunciation	:	i) (+) 24V DC centre tap grounded supply for general control purpose. ii) 240V AC, 1 phase, 2 wire, 50 Hz, un-interruptible power supply source (UPS).

NOTES:

1.0 *Supply Variations

i) Variation of supply voltage : (±) 10%

ii) Variation in supply frequency : (±) 5%

iii) Combined voltage and frequency variation : (±) 10%

VOLUME-II-
Section-C
PART-2

C-2: SPECIFIC TECHNICAL REQUIREMENTS FOR KAIGA 5-6

VOLUME-II-
Section-C-
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C-2: SPECIFIC TECHNICAL REQUIREMENTS
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Section-C
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C-2: SPECIFIC TECHNICAL REQUIREMENTS
C-2-1: C-2: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES FOR-KAIGA 5&6

NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Government of India Enterprises)

PROCUREMENT SPECIFICATION NUMBER : KAIGA- 5&6/40000/ PROCUREMENT SPECIFICATION/ MS-1
PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND PACKAGE

SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES FOR KAIGA 5&6

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Reviewed By	**N.M.RAO, AD (Civil)**		**21/12/2018**
Approved By	**ARVIND SHRIVASTAVA AD (Civil) & Head (Civil Engineering Group)**	21/XII/2018	**21/12/2018**
	(Name & Designation)	**(Signature)**	**(Date)**

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PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND
SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS
OF CIVIL STRUCTURES

REV. NO. / DATE	DESCRIPTION	PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY

1. GENERAL

1.0.1 PROJECT

The proposed project of KAIGA 5-6 consists of two units of 700 MWe PHWR type Nuclear Reactors.

1.0.2 LOCATION

The site is located in Kaiga Village, Karwar Taluka, Uttara Kannada District, Karnataka state. Kaiga Site bounded between the Latitude 140 50’ 29” - 140 52’ 59’ and Longitude 740 24’ 30”-740 27’ 40”at East-West and North-South sides respectively. Kaiga Site is at about 13 km upstream of Kadra Dam and associated hydro-electric power house on the left bank of Kali River on the banks of the Kadra reservoir. Geographically the site surrounded with hills covered with thick ever green forest at three sides and one side Kadra reservoir. The site receives an average rainfall of 3900 mm during the four months of monsoon (June to September).

1.0.3 ACCESSIBILITY

Access (Road, Rail and Air Connectivity)
Kaiga site is accessible from Karwar through State Highway 06 (SH-06) by taking 3 km diversion from SH06 at Hartuga. SH-06 is interconnected with SH-34 at Kadra and NH-66 at Karwar. Hence the nearby towns like Dharward, Hubballi, Belgaum, Goa etc. is connected. The nearest Broad gauge rail connectivity exists at Karwar on Konkan Railway and Londa on Belgaum-Goa broad gauge of South Western Railway Division. Air connectivity exists with Goa, Hubballi and Belagavi at 140, 150 and 175 kilometre respectively from Kaiga Site.

1.1 GENERAL GEOLOGY OF THE SITE

The plant site forms a part of the Peninsular Gneissic Complex of Uttar Kannada District. These tonalitic gneisses (plagioclase or sodalime feldspars are greatly in excess of orthoclase or K feldspars) with age > 3000 million years form basement rock and are overlain by metasedimentary rocks (Quartz schists, Qtz-sericite schist and Banded Magnetite quartzite) and Metavolcanics. The contact between the granite gneiss and metavolcanics is about 1 km south of Kaiga village. Granite gneisses are traversed by few basic dykes (delerites) and bodies of ultrabasic rock (pyroxenite, peridotite, gabbro and diorite). One such body also occurs within 4 to 5 km South East of the site area. The relevant borelogs in TI area (BH-110 & BH -113) are attached with the tender. It is observed that in one of the boreholes (BH-113) rock with low core recovery and RQD exists upto 58M depth from the existing ground level. ***In such situation contractor may require to use Pile- Raft foundation for the structures and the provision for the same shall be included by the contractor in his bid without any extra cost to NPCIL.***

1.2 METEOROLOGICAL DATA

The other meteorological parameters at Kaiga are as follows:

		Max.	Min.
1.	Air temperature	43.21	8.25

The annual maximum rainfall of 5708.2 mm and minimum rainfall of 2308.2 mm and average annual average rainfall is 3645mm. The maximum daily rainfall of 469.3 mm on 12/06/1999 (data from 1901 to 2010).

1.3 SEISMOLOGY

The site falls in zone III as per IS: 1893 and corresponds to an earthquake intensity of VII or less, as per Modified Mercalli Intensity Scale. The digital values of Response Spectra for safe shut down earthquake condition shall be given at a later stage.

1.4 SITE INSPECTION

The contractor is deemed to have visited the site and familiarized themselves thoroughly with the site conditions before submitted their tender. Non-familiarity with site conditions will not be considered a reason either for extra claims or for not carrying out the work in strict conformity with drawings and specifications. For any information on site visit, the tenderers may contact the office of CCE, Kaiga 5&6, Post Kaiga, Karwar, Karnataka State, Pin-581400.

1.5 SITE CONDITIONS

The bore hole location Drawing No. KAIGA-5&6/10120/2001/DD-R1 is enclosed along with the tender document. Typical details of a relevant Bore log data BH-110 & BH 113 are given at the end of this section in Annexure-1 for general guidance to the Bidders. All the geotechnical investigations as indicated (within the TI Package) in the drawings will be performed by the Purchaser and report of same will be made available subsequently for guidance. Any additional geo-technical investigation required for satisfactory analysis and design considering typical foundation pattern adopted by the bidder shall be carried out by him at no additional cost to NPCIL.

The bidders are advised to study the bore log data for information. The details of other bore log data in balance area of plant will be available in the office of the Engineer for reference of the bidders, if needed.

The finished grade level of EL 99.7m corresponds to RL 41.300.

For detailed geology around Turbine Building & other structures, para 2.1.1 may be referred.

1.6 BUILDING DESCRIPTION

Description of Main structures covered in the scope of this tender are as follows:

1.6.1 **TURBINE BUILDING** :

The Turbine buildings are located to the East of Control building. The Structure of the Turbine building shall be of reinforced concrete and shall be supported on Raft Foundation resting on competent rock. If required, piles shall also be provided below Turbine Building raft without any extra cost to Purchaser. For wall/cladding , Concrete Block Masonry is to be provided unless approved otherwise by the engineer. The RCC roof shall be made without any internal support, in order to avoid any interference in work being carried out below the roof. The roof shall be provided with water proofing with thermal insulation as per specifications. All the fire rating & other technical requirements shall be considered while selection of material & sizing of the members. Each turbine building shall be accommodated within the allocated maximum plan size as shown in the main plant layout drawing. The location of buildings in the main plant lay out is shown in Drg. No. KAIGA 5&6/10000/2001/GA enclosed along with the tender. A portion below condenser shall be lowered appropriately for cooling water inlet and outlet pipes.

The turbine building shall have floors and mezzanine floors at various elevations, housing the turbo generator and other components like HP Turbine, LP Turbine, Generator, Moisture Separator & Reheater, Deaerator, HP and LP feed water heaters, Condensate Extraction Pumps, Boiler Feed Pumps, Storage tanks, Vacuum pumps, Generator Circuit Breaker, Bus Ducts etc. The description given above is brief only . For detailed description relevant chapters of the tender may be followed.

For industrial & fire safety requirements relevant AERB & other statutory guidelines as applicable shall be strictly adhered.(Refer C-1-3)

The Turbine Generator(TG) shall be supported on a separate RCC pedestal and Reinforcing Concrete Raft foundation resting on competent rock. If required, piles shall also be provided below TG raft without any extra cost to Purchaser . The TG foundation shall be isolated from the main turbine building, so as to avoid transmission of vibrations or any other kind of forces to the main building.

Inside the building, EOT cranes with other suitable crane girders shall be provided, to handle the heaviest load within the building for maintenance & erection of Turbo Generator & other equipment except Turbo Generator Stator. During maintenance provision of removable leak-tight opening shall be made in the roof of Turbine Building for removal of Turbo Generator Stator. The building shall have necessary cable & Pipe trenches / tunnels, racks, pipes, hangers & anchor supports. The lifts as well as stair cases shall be provided to access from one floor to another floor of the building.

The access to Turbine building from Control Building at various floors shall also be

provided through proper connecting walkways, landing, Staircase etc. Floor levels & entry location from control building , are at similar locations as given for GHAVP project in drawing GHAVP 1&2/24200/ 2011 TO 2018/ GA. The connecting structure (Access Bridge) shall be planned & designed in such a way that it does not transfer any load to control building as the same is not considered in the design of control building.

In addition to above, condensate storage area & ventilation buildings, are to be provided by the side of Turbine buildings as indicated in the Drawing No. KAIGA 5&6/10000/2001/GA enclosed along-with the tender.

Annex Buildings are located by the side of both the Turbine Buildings. One of the Annex Building houses the Workshop alongwith other facilities, whereas other Annex Building houses the Laboratory with other facilities. For details of various facilities in the Annex Buildings Chapter C-1-3 of the Tender may be referred. The Annex building may be designed by the bidder as standalone structure or could be a part of the Turbine Building.

The construction of a local Control center inside turbine building with noise barrier/acoustic insulation as specified is also included in the scope of bidder, The detailed requirements of same which are indicated C&I specifications in chapter C-2-4 are also to be met .

1.6.2 **Pipe Cable Bridge (PCB):**

The Pipe and Cable Bridge (PCB) connecting Control building to Turbine Building shall have RCC Structure with suitable foundation resting on competent rock and the same is included in the scope of this tender . If required, piles shall also be provided below raft without any extra cost to Purchaser . The intermediate floors & roof of PCB shall be of RCC. The roof shall be provided with water proofing with insulation as per specifications. ***The structure of PCB shall be planned in such a manner that it does not interfere with the vehicular and equipment movement on 10 m wide (7m carriage bay and 1.5m wide shoulder on either side of road) road , as well as tunnels & trenches laid under the road****. The tunnel & trenches in this area are similar to the one given in GHAVP 1&2 and as indicated in drawing no GHAVP 1&2-29700-5002-GA.*The PCB foundations should not transfer any load on tunnels & trenches.

The floor elevations of Turbine Building shall preferably match with Control building floor levels. (Floor levels of control building are similar to GHAVP project and as given in drawing Nos. GHAVP 1&2/24200/ 2011 TO 2018/ GA, along with this tender). The width of PCB shall match with the PCB opening at control building end as shown in above mentioned drawings ,however the length of PCB will depend on the size of Turbine building as finalized by the bidder and approved by the purchaser. ***The PCB structure shall be planned & designed in such a way that it does not transfer any load to control building.***

1.6.3 **Electrical Bays:**

The electrical bays shall be provided adjoining to main turbine buildings. The electrical

bay houses Switchgears and Motor Control Centers. The size , layout & equipment arrangement of electrical bay shall be as specified in section C-2-3 of the Tender. The Structure of the Electrical bay shall be of RCC with Raft Foundation resting on competent rock. If required, piles shall also be provided below raft without any extra cost to Purchaser . The roof shall be provided with water proofing with thermal insulation as per specifications. All the fire rating & other technical requirements shall be considered while selection of material & sizing of the members. ***The engineering of the Electrical Bay shall be carried out on the basis of equipment layout and other input as finalized by the Purchaser & given in the electrical specifications in section C-2-3.***

The present layout of Electrical bays is finalized based on the structural configuration and sizing of various columns, beams etc. as per drawings attached in section C-2-3. It is expected that bidder shall maintain the same, while design of Electrical Bay Buildings . In case, it is found to be essential to change the given dimension and same is approved by Engineer, the Purchaser may modify the equipment layout, opening arrangement etc, to meet the design, construction and maintenance requirements. In such situation, Bidder shall carry out the necessary design changes based on modified layout by the purchaser without any extra cost to Purchaser.

1.6.4 **Access Bridge:**

The Access bridge for both the units needs to be provided to connect the turbine building from control building from each floor of Control building. This structure shall have landing at each floor of Turbine Building connected to nearest available Control building floor. It shall also have provision of lift, to access the Turbine Building & Control building. The floor elevations of Control building at which turbine building to be connected with control building are similar to GHAVP project and as given in drawing Nos. GHAVP 1&2/24200/ 2011 TO 2018/ GA . The Access Bridge structure shall be RCC. The roof shall be provided with water proofing with insulation as per specifications. Lift shall open at all floor levels of CB & TB.

1.6.5 **CCW Inlet & Outlet Pipes / Conduit**

The detailed requirement for CCW Inlet & Outlet Pipes/ Conduits given in Section C-2-5 shall be met. Suitable arrangement viz. culvert etc. shall be made to ensure that no loads are transferred by other Structures & Systems under this package on CCW Pipes/ Conduits.

1.6.6 **Transformer Yard:**

All the civil works for transformer yard (adjoining to turbine buildings & electrical bay) to accommodate SUT, UT, GT, Oil Separation Pit, Bus Duct, Rail Track (including rails) for maintenance upto Turbine building, spare GT area, fire barrier walls etc. are included in the scope of the bidder as shown in the relevant tender drawing. **The supply and erection of rail on road towards western side of grid X-2 is also included in the scope of bidder**. For detailed scope Section C-2-3 shall be referred. The transformer yard is open to sky. An area reserved for Transformer Yard

is shown in main plant layout drawing attached with the tender. ***The engineering of this area shall be done on the basis of input data and equipment layout provided by the Purchaser as given in the electrical specifications in Section C-2-3.The foundation for all the equipment & structures shall be Raft or Pile- Raft foundation, unless approved otherwise by the Purchaser. In case of raft foundation, the foundation shall rest on competent rock for SUTs, UTs, GTs, Burnt Oil Pit and Fire wall etc. (unless specifically approved by the engineer).*** The equipment foundations shall be structurally isolated from the grade slab to avoid any transfer of load.

1.6.7 **Tunnels & Trenches around Turbine Building & Transformer Yard (Other than CCW Pipes/conduits) & other area:**

The engineering & construction of all the tunnel trenches within the road edges between grid (8&9), Grid (26-27), grid (r2- q2) & grid (x2-y2)is included in the scope of bidder. The terminal points are similar to GHAVP project and as given in Sketch No. GHAVP 1&2/29700/2001/SK. The end of the RCC tunnels shall be provided with proper construction joint & dowels of adequate length which can be used by other agency for further construction. (The load being transferred, if any, at terminal point and is to be accounted for, during design by TI package contractor to be specified.) The tunnels / trenches shall be aligned & engineered properly considering the road crossing etc, if any, as per overall layout of the plant. The Tunnel trenches included in the scope are similar to GHAVP 1&2 (Ref: GHAVP 1&2/29700/2001/SK):

- PTL 26, 33(upto terminal point),53,96,97
- PTR 26A , 26B & 68
- CTR 72,74, 74A,75, 77,78,79, 80
- CTL 73, 73A(upto terminal point), 73B, 94 (upto terminal point), 95, 95A
- ASW tunnels upto terminal points in East & West direction.
- Any additional tunnel / trenches / pipes required within the terminal of this contract, are also included in the scope of bidder. The portion of the tunnels/ trenches which is excluded from the scope of this package are similar to the one specifically mentioned in the Sketch No . GHAVP 1&2/29700/2001/SK given with the tender.
- The layout of Major Surface drain will be provided by the purchaser to the bidder on its finalization . Design and construction of down comer pipes & additional internal drains connecting to the Surface drains is in the scope of bidder. Construction of Surface drains within the terminal boundaries as specified in para 1.6.7 is in the scope of bidder. The relevant sectional details & Layout, given in construction *drawings supplied by the Purchaser (at a later stage)* shall be followed, in order to meet the continuity of flow as these are part of overall drain network of plant.
- The layout of Plant drain will be provided by the purchaser to the bidder on its finalization . Design and construction of additional internal plant drains connecting to the nearest available plant drains shown in above drawing is in the scope of bidder. Design (wherever not supplied by the bidder) & Construction of plant drains within the terminal boundaries as specified in para 1.6.7 is in the scope of bidder. The relevant sectional details & Layout, given in construction *drawings supplied by the Purchaser (at a later stage)* shall be followed, in order to meet the continuity of flow as these are part of overall drain network of plant. In case the manholes for above services are not

available, close to terminal boundaries, then these lines are to be connected by the bidder at his own cost to the nearby Man Hole/ nearest connecting point at the boundary limit.

- The layout of Roof drain will be provided by the purchaser to the bidder on its finalization. Design (wherever not supplied by the bidder) & Construction of Roof Down Comers & Drains within the terminal boundaries as specified in para 1.6.7, is in the scope of bidder. The relevant sectional details & Layout, given in construction *drawings supplied by the Purchaser (at a later stage)* shall be followed, in order to meet the continuity of flow as these are part of overall drain network of plant. In case the manholes for above services are not available, close to terminal boundaries, then these lines are to be connected by the bidder at his own cost to the nearby Man Hole/ nearest connecting point at the battery limit.
- The layout of Sewer drain will be provided by the purchaser to the bidder on its finalization. Design (wherever not supplied by the bidder) & Construction of sewer line from building to the nearest manhole outside the terminal boundaries as specified in para 1.6.7 is in the scope of bidder. The relevant sectional details & Layout, given in construction *drawings supplied by the Purchaser (at a later stage)* shall be followed, in order to meet the continuity of flow as these are part of overall drain network of plant. In case the manholes for above services are not available, close to terminal boundaries, then these lines are to be connected by the bidder at his own cost to the nearby Man Hole/ nearest connecting point at the boundary limit.
- The construction of 10 m wide road between grid 17- 18 within terminal point is excluded from the scope of the bidder. However the bidder shall fill the area up to subgrade i.e. EL 98.0m , with material as per specifications and/or as approved by the purchaser.

1.6.8 The construction of Hard Stand "C" is excluded from the scope of this tender. However, the area below the Hard stand within terminal point shall be graded upto EL 98.00 with material as per technical specifications and/or as specified by the Engineer suiting for operation of crane for handling the Turbine Building equipment like Deaerator, Tubo-generator, MSR, LP Turbine & HP Turbine .

1.6.9 **Area grading within the terminal points:**

The area grading within the terminal point within the road edges between grid (8-9), Grid (26-27), grid (r2- q2) & grid (x2-y2) , upto EL 99.7M (RL 219.3M) is within the scope of bidder. For area grading backfilling upto EL 99.7M shall be done using material as per the technical specifications and as approved by the Purchaser, unless specified in the approved drawing otherwise .

1.7 SCOPE OF CIVIL WORK

1.7.1 **General:**

The works proposed to be performed under this contract are for engineering, procurement, fabrication, construction, commissioning and handover of two 700 MWe units of Kaiga Atomic Power Project - 5&6 (KAIGA- 5&6) and shall include all the facilities required for power production utilizing the steam produced in secondary

cycle. ***The facilities shall be established within the allocated area satisfying all the statutory, technical and performance requirements specified in the tender.*** The work shall generally include but not limited to following:

Finalization of equipment layout, general arrangement, loading, analysis , design , drawings, procurement, fabrication, construction & commissioning of :

- Turbine Building including BFP, CEP and Vaccum Pumps.
- Turbo Generator Foundations
- Foundation of all other equipment's
- Annex Building ,Turbine Oil storage tank
- Condensate storage tank and its storage area
- Pipe and Cable Bridge (PCB) structure connecting Control building to Turbine Building
- Electrical bay (The engineering of the building is to be carried out on the basis of equipment layout and other input finalized by the Purchaser or his consultant as given in the Electrical Specification.).
- All other Tunnels , Trenches & pipes within the terminal boundaries except similar to those which are specifically mentioned as excluded in the sketch No. GHAVP 1&2/29700/2001/SK.
- Transformer yard accommodating SUT, UT, GT, Oil Separation Pit, Bus Duct, Rail yard for maintenance upto Turbine building including rails in transformer yard to & within the turbine building unloading bay, spare GT area . The supply and erection of rail on road towards western side of grid X-2 is also included in the scope of bidder.
- Embedded parts / Penetrations,
- Access bridge to connect the turbine building from control building from each floor of Control building (The floor elevations of Control building at which turbine building to be connected with control building are similar to GHAVP project and as given in drawing Nos. GHAVP 1&2/24200/ 2011 TO 2018/ GA) .
- Surface drains, Plant drains, Roof drains and Sewer lines (Based on the engineering input provided by the purchaser)within the terminal point as specified in Para 1.6.7.
- Internal & External Finishes, cladding , plastering , flooring & painting etc.
- Fabrication & erection of all structural steel works like trusses , crane girders etc.
- Dewatering of the area
- Area Grading & temporary access roads within the terminal point
- All the civil, structural & architectural works as necessary for completion of the system.

1.7.2 **Detailed:**

The scope of work shall include engineering, procurement, supply & construction necessary for functional requirements. The work shall generally include but not limited to the following :

(a) ***The excavation of site will be carried out within the terminal points of this package by the Purchaser as indicated in the drawing no*** KAIGA 5&6/16000/2003 /SK**.** ***However, additional excavation, if any required from functional reasons due to system requirements or due to geotechnical reasons , shall be carried out by the contractor at his own cost. Wherever, the founding levels are lower than the levels***

specified in above drawing the ground shall be lowered by bidder using appropriate cutting tool like , rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. The over excavated / damaged ground, if any, shall be made good by the bidder at his own cost. Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure.

Back filling of areas, wherever required, shall be done using suitable backfill material as decided by the Engineer, and is included in the scope of this tender. The same shall be done by the bidder at his own cost. The area under the structures shall be raised, by filling PCC only unless approved otherwise by the Engineer

The bidder has to carry out at least following confirmatory geological tests for both the buildings independently, to demonstrate the suitability of geotechnical parameters considered, in his design within the area covered in the scope of the bidder unless approved otherwise by the Engineer.

- ***minimum one bore hole of nx size (As required, but not lesser than 60m depth from founding level),***
- ***analyzing & arriving at safe bearing capacity using RMR & Unconfined compressive strength of core (having a minimum factor of safety of 10) approach. and a lesser of these 2 values shall be considered in the design in case of rock.***
- ***cyclic plate load tests under TG foundation area &***
- ***Geological mapping at the founding level of foundation & its side area,***

The bidder shall also carry out the ground improvement by consolidation grouting as per IS 6066 & conduct the water loss test as per IS 5529(Part 2), unless approved otherwise by the Engineer. All the above activities shall be executed as per the relevant technical specifications detailed in subsequent clauses of this tender.

(b) Analysis ,Design and Detailed Engineering of all the structures i.e. covered in the scope of this tender and as detailed above.

(c) Preparation of Design Basis Reports (DBR), Static and dynamic analysis reports and other design reports as applicable and suggested by the engineer.

(d) Preparation of general arrangement, loading, Architectural , concrete forming, EP location, EP fabrication and Reinforcement drawings etc. The reinforcement detailing has to be as per Indian Standards/ ACI/ AERB code as directed by the engineer.

(e) Complete analysis , design, procurement ,fabrication and erection of structural /Miscellaneous Steel works & EP including preparation of all necessary drawings within the terminal points & within the scope of this tender.

(f) Preparation of composite drawings including details of Civil, Electrical, Mechanical, Instrumentation etc.

(g) Preparation of Bar bending schedule and Bill of materials.

(h) Design , fabrication and erection of formwork and supporting system required for concreting of the various elements of the structure.

(i) All Reinforced concrete work in pile (wherever applicable), raft, isolated footings, columns, equipment foundations, slabs, beams, underground tunnels/trenches, sumps, basement structures, ducts, precast covers and allied structures etc.

(j) All RCC work required for equipment machinery, tanks, tunnels , trenches etc., supply & installation of EPs.

(k) Supplying and Fixing water stops, expansion joint.

(l) Supplying & Construction of brick, concrete block walls along with plastering , glazed walls, Metal deck sheeting, cladding & roofing as per the drawings .

(m) Providing & fixing the Metal Doors/ Fire proof doors, Windows, Ventilators & Louvers with glass & glazing along with all the necessary fixtures wherever required or as specified by the Purchaser. Wherever required, suitable sound insulation measures shall be provided.

(n) Providing and laying of plant drain, storm water drains, sewer lines, roof drains, UPVC pipe down comers and different pipes and other plumbing and sanitary works and connecting the sewer lines to nearest manhole outside the area within this contract or as required.

(o) F3 & U3 finishes to the concrete.

(p) Hardonate flooring by vacuum de-watering method and other types of flooring as specified in the specifications, including specific requirements given in other sections of the tender.

(q) Painting over concrete , structural steel , wall, ceiling, Doors , Windows & Ventilators etc. wherever required as specified in the tender or else as directed by Purchaser.

(r) Water proofing work in basement, sump, wall and roof etc. as specified in the tender specifications or approved by the Purchaser.

(s) Providing facilities throughout the contract period for sampling and testing of various construction materials as specified and as directed by Purchaser.

(t) Providing proper storage facilities for construction materials such as cement, steel, aggregate, admixture, Structural Steel, water stop, paints etc.

(u) Construction of temporary Access Roads & storm water drains within the terminal points .

(v) General area grading and drainage within the terminal points upto EL 99.7M unless specified otherwise, with proper retaining walls / sheet piles (wherever required) .

(w) Providing suitable dewatering system in order to keep the excavation dry at all times during the construction period , the contractor shall provide adequate standby arrangement for pumping water in case of power failure.

(x) Finishing works for above mentioned structures, partition walls. plastering, flooring, painting, false ceiling wherever specified & approved in the drawings, erection of doors, windows & rolling shutters, P.H. Works, waterproofing, construction joints, fire proofing, painting of equipment, structures and piping etc.

(y) Preparation of quality assurance plan, quality assurance manual, testing methodologies Inspection and testing plan, and acceptance criteria for material qualification.

(z) Preparation of construction methodology, safety manual, job hazard analysis, work procedures, etc.

(aa) Submission & obtaining the purchaser approval on Construction Completion Certificate & system transfer docket containing necessary documents like Test Certificates, Pour Cards, As Built Drawings & Inspection reports etc.

(bb) Attending meetings with purchaser, AERB, wherever & whenever required, at own cost.

1.8 MATERIAL AND SERVICES BY NPC

Land, water and power etc. will be given by NPCIL on chargeable basis on conditions mentioned elsewhere in the relevant documents.

The supply of all the materials , required to execute the work covered under this contract, is in the scope of contractor.

1.9 DRAWINGS

Drawings being issued with bid are for ***guidance*** only. All the construction/ as-built drawings are to be prepared by bidder on suitable integrated engineering environment or AutoCAD (latest version) as per relevant standards and as specified by purchaser . Drawings in Compatible AutoCAD version shall also be provided to the purchaser. Contractor should have adequate knowledge of prevailing codes and practices for reinforcement detailing .

3 number of prints (full scale) of each drawing shall be submitted to Purchaser for every revision/correction. Drawings /Documents preparation, checking and Approval of drawings shall be done by the EPC contractor as well as design consultant (if

appointed) and same shall also be approved by Proof consultant. Before submission to Purchaser all documents should bear the signatures and names of persons preparing, checking and approving the documents/drawings as well as of Proof consultant .After the approval from Proof consultant the Drawings /Documents shall be submitted for final acceptance of Purchaser. Purchaser comments if any shall be incorporated in the relevant final drawings/ documents prior to execution.

Supporting design calculations (wherever applicable) shall also be submitted by EPC contractor prior to submission of related drawings. Two copies of the approved prints and one set soft copy shall be submitted to the Purchaser. The final soft copy of all the documents and drawings will be registered in Purchaser's document management system (PLM) in the format attached with the tender, progressively with the work progress. Execution shall be done only after proper registration of the documents/ drawings.

Submission of DVD/ CDs (2 copies) of all approved drawings, DBR, Mathematical model, software input and output files, post processors , static and dynamic analysis reports, Design Manual etc , along with soft copy of executable file of programme, excel sheets used in the process of analysis and design are also included in the scope of bidder.

The documents/drawings furnished by Purchaser and/or generated by the EPC contractor shall not be used by the contractor anywhere else without prior written approval of the purchaser. All the generated documents/ drawings will be property of the purchaser.

The bidder has to prepare the following drawings:

(a) General arrangement, Loading, Architectural , Concrete forming, EP location, EP fabrication, Reinforcement drawings etc. for all the structure covered in the scope of this contract. The reinforcement detailing has to be carried out as per Indian Standards/ ACI code as directed by the purchaser .

(b) Design of Joints, preparation & issue of fabrication drawings for Structural Steel works & other Miscellaneous Steel Structures.

(c) Preparation of Bar bending schedule and Bill of materials (BOQ).

(d) Preparation of composite drawings including details of Civil, Electrical, Mechanical, Instrumentation etc.

(e) Preparation of EP list

The bidder has to prepare all the drawings/ Report as per the approved format of the Purchaser. A period of minimum 15 working days shall be considered for obtaining the Purchaser's comments after submission of drawing / Document by the Contractor.

1.10 SPECIFICATIONS

The specifications given in this document cover the general description, quality and workmanship of materials and finished work. They are not intended to cover minute details. The work shall be executed in accordance with best modern practices.

For all the Civil works these specifications shall have precedence in case anything contrary to this is stated anywhere in the contract document, unless specifically mentioned in this document or approved by the engineer. The Purchaser's decision shall be final, on any issue arising out of such discrepancies.

1.11 PARTICULARS OF THE MATERIALS TO BE USED BY THE BIDDER:

The bidder has to use the following materials for civil construction unless otherwise specified /approved by the Engineer in writing

- **Backfilling:**

A) AREA GRADING:

Upto EL 99.70m : As per technical specifications and as approved by the engineer

B) Within Foot Print of structure/ equipment Foundation:

PCC shall be used, unless specifically approved by the Engineer. The properties of the back fill material used shall be suitably accounted in the design.

- **CONCRETE : M 35 Grade**

- **PCC: M15 Grade**

- **STRUCTURE-**

Foundation Type : RCC Raft or RCC Raft with Piles (wherever required)

Structure above Raft: Reinforced Cement Concrete (RCC), unless approved otherwise by the Purchaser.

- **WALLS :**All external walls shall be of Concrete Block Masonry, unless approved otherwise by the Engineer . Wherever required, proper glass partitions shall also be provided.

- **ROOFING :**

The roof of Turbine buildings shall be cast in situ RCC (with water proofing and required thermal insulation as per specifications) over Steel Deck Span Sheets, unless specifically approved by the Engineer. The roof of Turbine Buildings shall be laid over steel roof trusses and purlins. The roof shall be made without any internal support from slab below in order to avoid any interference in work being carried below the roof.

The floors & roofs (Except for Turbine Building) shall be of cast in situ RCC (with water proofing and required thermal insulation on roofs) .

❖ **PLASTERING : On masonry works**

A)EXTERNAL: 20 mm thick rough cast plaster / sand faced plaster wherever masonry is used for cladding and as approved by purchaser.
B) INTERNAL: 15 mm thick cement mortar

❖ **FLOORING :**

40 mm thick Hardonate flooring in cement concrete 1: 1.5: 3 or alternative flooring or as functionally required & approved by the purchaser.

The areas used for handling the chemicals and battery rooms shall be provided with acid & alkali resistant lining .

In case, if specific flooring requirements are specified in other sections of the tender the same shall be followed unless otherwise agreed by the engineer.

❖ **WATER STOP :**

PVC type as required & approved by the purchaser.

❖ **WATER PROOFING:**

FOR ROOF :

Spray Applied 2 component Polyurethene Membrane as per specifications on all RCC roofs . Wherever required, proper thermal insulation shall also be provided .

FOR BASMENT / TUNNELS/ TRENCHES /SUMPS:.

PVC Membrane as per the technical specifications. PVC membrane shall also be provided all around CEP foundation external surfaces.

❖ **PAINTING**

A) INSIDE SURFACE :
On masanory walls upto 2 m height 250 micron thick epoxy paint & for balance height acrylic emulsion paint of shade to be approved by purchaser.

B) OUTSIDE SURFACE ABOVE GRADE LEVEL:
Anti-Carbonation, Anti-Corrosive and Waterproof Coating on plastered/ concrete surface of shade as approved by the purchaser.

C) STEEL STRUCTURE:
Epoxy paint as specified in clause 19.18.5.5, unless specified otherwise.

D) FLOOR :
1200micron thick Self-Leveling Epoxy coating on Turbine operating floor. On all other floors except for Turbine operating floor, 500 micron thick epoxy paint shall be used.

In areas where any other specific type of flooring like Acid Alkali Resistant Lining etc. (other than Hardonate flooring) is specified, epoxy coating need not be provided.

E) FIRE PROOFING OF STEEL STRUCTURE:
Using Intumescent Paint for desired fire rating or encasing in concrete as specified in the drawing and approved by the Engineer.

❖ **DOORS/ WINDOWS :**

Anodised aluminum doors / steel rolling shutters and anodised aluminum windows as approved by the purchaser .Wherever required, fireproof doors shall also be provided of adequate fire rating.

❖ The false ceiling shall be provided, wherever specified in the tender (inclusive of other sections).

1.12 GENERAL & ARCHITECTURAL REQUIREMENTS

1.12.1 *Grade of concrete*

All the cement concrete works involved in the Turbine Building& other associated structures shall meet the requirements for relevant IS standards.

Grade of concrete shall be M35 for sub-structure and for super-structure. The RCPT value of the concrete used for the construction shall not be more than 2000 columbs at 56 days.

1.12.2 *Types of cement*

The cement shall be OPC 43 grade confirming to IS 8112 or OPC 53grade confirming to IS 12269 as well as the additional requirements of technical specifications . To meet the durability requirement, mineral admixture like flyash may be used with proper mix proportioning . The quality of fly ash shall meet the relevant technical specifications.

1.12.3 *Reinforcement*

The reinforcement shall be HYSD TMT bars of grade Fe 500 as well as the additional requirements of relevant technical specifications shall be used.

1.12.4 *General Architectural Requirements*

Powder coated aluminum panel of minimum 0.5mm thick lined ceiling (closed type pattern) fixed to R.C. beams shall be provided for all air-conditioned areas. The illumination and duct grills in these areas shall match the overall aesthetics.

All the buildings shall be provided with minimum 1.0m wide concrete paving all round as plinth protection. Paving shall be slopped outward to provide a rapid run off rainwater away from building.

Doors, windows and rolling shutters on external walls of buildings shall be provided with sunshade with side projections .Sunshade from walls shall be minimum 750 mm over windows & doors and 1500 mm over rolling shutters.

All stairs shall have a maximum riser height of 175mm and a minimum thread width of 250mm with Aluminum nosing. Minimum width of stairs of in all building shall be 1200mm.

Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 3.0m and number of riser shall not exceed 12 for a single flight.

Hand railing minimum 1100mm high shall be provided around all floors/roof openings, projections, balconies, walkways, platforms, etc. ***All hand rails, toe guard, balustrades, vertical posts& horizontal rails of RCC staircases connecting the floors& railings around openings in RCC floors shall be of Stainless steel*** . Other hand rails shall be 32mm nominal bores MS medium quality pipes and shall be coated with 2 coats of high build epoxy paints with suitable primer. Vertical spacing of landings shall not exceed 1.5m center to center. Minimum 2 numbers 32NB GI pipe shall be provided for horizontal rails and toe guard shall be provided. All rungs for ladder shall also be coated with 2 coats of high build epoxy paints with suitable primer as per specifications.

All steel platforms above grade shall be constructed with 150 wide kick plates at edge of platform to prevent tools or materials from falling off platform.

Doors shall be provided at appropriate location to prevent dust ingress from outside.

Rolling shutter size and its operating system shall be decided based on the equipment handling for erection and maintenance with a side clearance.

All windows/louvers shall be of anodized aluminum .

External cage ladder shall be provided for access to Turbine building roof. Internal cage ladder 2 nos. shall be provided to access crane walkway .

All the edge protection angles shall be coated with 2 coats of high build epoxy paints with suitable primer.

1.12.5 *Glazing*

Glazing partition wall shall be provided in areas wherever required and as approved by the Engineer.

Glazing shall be in double toughened glass with glass of minimum 6mm thickness for effective thermal insulation. Vision panel shall be minimum 4mm thick.

Windows & ventilators located on external walls above operating floors levels and those located in fire prone areas shall be provided with wired glass of minimum 6mm thickness. Windows in other areas shall be finished with 6mm thick clear glass.

1.12.6 *Flooring*

The nominal total thickness of floor finish shall be 40mm. The areas used for handing of chemicals shall be provided with Acid & Alkali resistant Lining. Wherever, special type of flooring is required due to functional requirements or mentioned in other sections, the same shall be provided.

Skirting shall match with floor finish.

1.12.7 *Roof Drainage System*

A 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:

Roof Drain Heads
Rainwater down comers
Fixtures

IS:1742 code of practice for buildings drainage shall be followed for this purpose.

Multiple drains (min.2nos.) shall be provided for all roof areas. System will be designed to handle rainfall at a rate of 160 mm per hour and in accordance with stipulations of IS:1742.

1.12.8 *Plant Drain, Surface Drain & Sewer Line:*

Construction shall be done as per the system engineered by Purchaser as specified in clause 1.6.7 above . Wherever additional lines are to be laid to connect the system engineered by Purchaser, shall be designed and constructed by Bidder.

1.12.9 *External Painting*

The building shall be provided with paint on external surface matching with the plant aesthetics as specified in clause 1.11 above.

1.13 LAYOUT

Only two main centre lines and one permanent bench mark would be furnished and all other lay out, fixing levels etc. shall be done by the Contractor at his own cost. The Contractor shall protect and maintain, during the course of execution of the work, the main centre lines and bench marks, so that they are left undisturbed even after completion of his work.

1.14 ACTIVITY SCHEDULE

The successful bidder has to prepare the detailed schedule and construction procedures for all major activities and submit the same for approval before commencement of work.

The work shall commence and completed in accordance with the Construction Schedule specified elsewhere. The various phases of work shall be completed within the periods as specified in the approved construction schedule, to be submitted by the bidder. The total completion period for this contract will be as given in the tender notice attached with this tender document.

2. DESIGN SPECIFICATIONS

2.1 PROJECT SITE FEATURES

2.1.1. LOCAL GEOLOGY

Seven Boreholes BH103, RBH-104,RBH-109, BH-110, RBH-111, BH-115 and BH-116 covers Turbine Building-5.

Seven Boreholes BH105, RBH-112, BH-113, BH-106, RBH-114, BH-117 and RBH-118 exists covers Turbine Building-6.

Boreholes RBH-107 & RBH -108 covers Transformer Yard of both the units.

The representative borehole data BH-110 & BH-113 are attached as Annexure-1 for guidance. The soil/ rock samples from boreholes will be tested & relevant data will be provided to bidder subsequently.

Subsurface profile at Turbine building -5 & 6 areas generally consists of top soil followed by laterite, boulders/sand and rock as indicated in representative borehole data BH-110 & BH-113.

2.1.2. SITE GRADING

The site selected for general layout of Turbine Building and other associated structure are located in a slightly sloped terrain. This area will be excavated by the Purchaser up to the levels as indicated in drawing No KAIGA 5&6/16000/2003 /SK. However, on completion of construction, this area will have to be graded to Finished Grade Level of RL 41.300 M.

i.e. EL 99.7 M and the same is included within the scope of this tender.

The finished floor level of all the structures is fixed at EL 100 000 i.e RL 41.600 M . The site will be graded to EL 99.700 M.

2.1.3. SEISMIC, SAFETY, QUALITY & DESIGN CLASSIFICATION

The site lies in Zone-III, as per the zoning map of India [IS-1893-2002, Part-1]. The structures within the scope of this tender are seismically classified category 3, safety class NINS (Not important from Nuclear Safety) & Design Class DC-4(Non Safety class structure.

2.1.4. METEOROLOGICAL CONDITIONS

Following meteorological data should be considered for design.

a) Annual average Rainfall: 3645 mm
Maximum Intensity /Hr for 1 Hr duration: 160 mm/hr
(for design of roof drainage)

b) Wind pressures : Following 3 sec averaged extreme wind speed for different return periods upto 10m height: shall be followed in the design.

i) 100 years return period: 44.07 m/sec
ii) 1000 years return period: 62.01 m/sec
iii) 10000 years return period: 79.95 m/sec

Height (m)	Vb (m/s)	k1 values for different return periods									
		50	100	1000	10000	k2	k3	50	100	1000	10000
10.00	39.00	0.99	1.13	1.59	2.05	1.00	1.00	38.61	44.07	62.01	79.95
20.00	39.00	0.99	1.13	1.59	2.05	1.07	1.00	41.31	47.15	66.35	85.55
30.00	39.00	0.99	1.13	1.59	2.05	1.12	1.00	43.24	49.36	69.45	89.54
40.00	39.00	0.99	1.13	1.59	2.05	1.15	1.00	44.21	50.46	71.00	91.54
50.00	39.00	0.99	1.13	1.59	2.05	1.17	1.00	45.17	51.56	72.55	93.54
60.00	39.00	0.99	1.13	1.59	2.05	1.18	1.00	45.71	52.18	73.42	94.66
70.00	39.00	0.99	1.13	1.59	2.05	1.20	1.00	46.25	52.80	74.29	95.78
80.00	39.00	0.99	1.13	1.59	2.05	1.21	1.00	46.80	53.41	75.16	96.90
90.00	39.00	0.99	1.13	1.59	2.05	1.23	1.00	47.34	54.03	76.02	98.02
100.00	39.00	0.99	1.13	1.59	2.05	1.24	1.00	47.88	54.65	76.89	99.14

c) Max Dry Bulb Temp : 43.21 ^{0} C (100 year return period)
d) Minimum Dry Bulb temp : 8.25 ^{0} C (100 year return period)

e) Relative Humidity

i) Max. during monsoon : 99.9%

ii) Min. during Dec to Jan : 3%

2.2 DESIGN

The design of the structures (unless specified otherwise) given in clause 1.6 &1.7 is in the scope of the Bidder. The design of the structures shall be done by the Bidder or his design consultant as approved by the purchaser .**The designer should have experience to design of similar structures i.e minimum one Turbine Building with Turbo generator Foundation of a power plant of minimum 500 MWe capacity of any Nuclear or Thermal Power Plant in rocky site (applicable for KAIGA 5-6 only, For GHAVP experience of TG design in Soil site is essential)**. ***The designer shall be acceptable & approved by the purchaser. The credentials of Designer shall also be provided along with technical bid.***

2.2.1 PROOF CONSULTANT

The successful bidder shall appoint a proof consultant(s) with the approval of the purchaser for independent checking of the analysis, design and drawing works carried out by the bidder or his design consultant. The bidder shall provide the names of his prospective design consultants (if appointed) and proof consultants along with his bid.

It is preferred that proof checking consultants are from institutions like IIT's or any other premier organizations or experienced professionals. The proof consultant shall have experience of analysis & design of machine foundation & framed structures. The proof consultant shall be acceptable & approved by the purchaser. The credentials of Consultant (if appointed) & Proof consultant shall also be provided along with technical bid.

All design related deliverables by bidder shall bear the certification by proof check consultant regarding the documents and drawings are in conformance to codal provisions and technical specifications.

2.2.2 GUARANTEE FOR DESIGN

The bidder shall furnish guarantee against fault in the design (even though it might have been accepted by the Purchaser)of the structures covered under his scope of work. Further he shall also carry out at his cost all necessary rectification/improvements in the design of structures covered under the contract so as to make good any inadequacy arising out of above factors. The approval of Purchaser does not absolve the bidder from the overall responsibility of satisfactory performance of design & construction of the works within his scope.

2.3 DESIGN PARAMETERS AND METHODOLOGY

The following design parameters and methodology shall be followed for structural/civil engineering design of Turbine building and other structures within this contract. ***The***

fundamental principle controlling the design and construction of all the structures is to ensure that functional performance is maintained at all times upto earthquake level of zone III of IS 1893 and structural integrity against collapse is also to be maintained under the extreme loading including Safe Shutdown Earthquake condition to ensure safety of the adjacent safety related buildings viz. Control Building, SAB etc.

In principle this shall be achieved through a combination of using the best quality control standards for material and workmanship during construction and designing for all severe load combinations, whilst imparting a high level of redundancy within the structural system.

2.3.1 DESIGN PARAMETERS

2.3.1.1 SAFE BEARING CAPACITY, FOUNDING LEVEL & OTHER GEOTECHNICAL PARAMETERS:

The safe bearing capacity at founding level of any structure shall be computed based on standard codal approach/ practices considering the geotechnical parameters of the influence zone, based on dimension of structure and maximum intensity of pressure. For finalization of influence zone, the foundation profile up to a depth, where net increase in vertical pressure becomes less than 10% of the initial overburden pressure from founding level of the structure shall be considered in the analysis.

The geotechnical parameters shall be evaluated based on bore hole data obtained on ground and required field test.

The foundation of all structures and major equipment of transformer yard (SUT, UT, GT etc.) & oil separation pit, CCW Inlet & hot water tunnel, PCB & Electrical bay, Turbine Building and Turbo-generator etc. shall be taken from competent rock or supported on pile unless specifically approved otherwise by the engineer and as approved by the engineer. All other tunnel / trenches may be engineered & founded on PCC / fillcrete, unless approved otherwise and as approved by the Engineer.

2.3.1.2 MODULUS OF SUBGRADE REACTION :

Based on the preliminary investigation, the modulus of subgrade reaction shall be determined from established theories under static & dynamic condition for all the structures, considering fck of concrete as 35 Mpa.

2.3.1.3 GROUND WATER

From the recording of ground water table observed in various bore holes during site investigation, it has been established that the bore holes and trial pit water level variation within the main plant area is quite erratic. And in most of the cases it is found within 2-4 m below existing Ground level.

As the foundations are below the ground water table, de-watering will be required during construction. Suitable de-watering system shall be adopted by the bidder during construction stage to maintain the water level 1 m below the founding level. All the foundations, retaining walls etc. will be designed taking into account worst conditions of ground water hydrostatic pressure. *As per the current practice for design and stability check purpose, ground water level will be taken upto finished grade level.*

2.3.1.4 EARTHQUAKE INDUCED LIQUEFACTION

The phenomena of Landslides, Collapse, Subsidence and Liquefaction depends on the nature of ground and prevailing sub-soil water conditions. The site is not found susceptible for Liquefaction hence not to be considered.

2.3.1.5 LOADS & LOAD COMBINATIONS

The following loads shall be considered in their worse combinations as appropriate for the design of the Turbine Buildings, Ventilation Buildings, Electrical Bay, Pipe & Cable Bridge , Transformer Yard area & CCW Tunnels etc.

a) Dead Loads

Dead loads comprise of the self-weight of all permanent construction, including walls, floors, roofs, ceilings, columns, stairways, cable shafts and fixed service equipment. While estimating dead loads for the purpose of design, the unit weight specified in IS: 875 Part-1 shall be used.

b) Equipment Loads

The buildings shall house a number of equipment on various floors. The loads from these equipments shall be specified as per vendor details.

c) Live Loads

Live loads on floors shall be considered as per the following sub-sections:

d) Uniformly distributed loads

The uniformly distributed live loads assumed shall be the highest values likely to be produced. The uniformly distributed loads are static loads on the plan area and provide for normal effects of impact but do not take into consideration special concentrated loads, which are been dealt below.

e) Concentrated loads

Except for offices, toilet blocks etc. all floor slabs, secondary beams and girders etc. (other than the operating platforms near the equipment) shall be designed for a concentrated load of 10000 N acting simultaneously with the uniform live load as given

in (i) to take care of any unforeseen exigent loads. This load shall be assumed to act at points so as to result in maximum moment and/or maximum shear. However, this load shall not be considered concurrently along with any actual concentrated load given to be carried over to the main beams, columns and foundations. For floor slabs, unless otherwise specified, this load shall be assumed to act as distributed uniformly over an area of 750mm square and shall be located so as to produce the maximum stress condition in the floor slab.

f) Live load on roof

Live load on roof shall be considered, as the roof is provided with access. The following provisions as per BIS 875 Part-2 shall be followed. The minimum live load on roof that shall be considered for design is 1500 N/sq m. but not less than 3750N uniformly distributed over any span of one meter width of roof slab or 9000N uniformly distributed over the span in the case of beams or truss or wall.

g) Loads on purlins supporting the RCC roof

Every purlin shall be designed to carry the more severe of the two loads indicated below:

- The loads transmitted to the member RCC roof in accordance with (f) and
- An incidental concentrated load of 10000N placed at the most unfavorable position on the member.

h) Loading on handrails, parapets etc

Stairway railings, hand rails, parapets and balustrades, both exterior and interior shall be designed to resist horizontal thrust of 750 N/m applied at the top of the railing.

i) Loads due to impact and vibration

Structures carrying live loads, which induce impact or vibration, shall be designed for minimum increased live load as follows:

Structures	**Min. Impact Factor**	**R e f e r e n c e**
a) For light machinery, shaft or motor units.	20%	BIS:875
b) For reciprocating machinery or power units.	50%	BIS:875
c)Transformer roller loads	10%	Assumed
d)Truck wheel load	30%	Assumed

Impact and vibration load for gantry girders, monorails etc.

For crane gantry girders and supporting columns, the following allowances shall be deemed to cover all forces set up by vibration, shock from slipping of slings, kinetic action of acceleration and retardation and impact of wheel loads –

Type of load	Additional load
a) Vertical loads for electrical overhead crane (EOT)/monorails	25% of maximum static wheel loads.
b) Vertical loads for hand operated cranes/monorails (HOT)	10% of maximum wheel loads.
c) Horizontal forces transverse to the rails for electric overhead cranes.	5% of weight of the crab and the weight lifted on the crane.
d) Horizontal forces along the rails for EOT cranes.	5% of the static wheel loads.

The horizontal forces specified in (c) & (d) shall be considered as acting at the rail level.

For monorails no horizontal surge shall be considered.

j) Construction Live Load

These are the superimposed loads, which may come on a member during construction or after construction as erection loads.

k) Soil/Earth Pressure

Turbine building with C.W. Pit basement walls shall be subjected to lateral earth pressure for the portion where sides of the wall are back-filled. The walls shall be subjected to earth pressure at rest derived as per standard formulae.

l) Hydrostatic Pressure

The basement walls shall be designed considering the subsurface water pressure rising up to finished grade level, as approved by the engineer, under normal and severe environmental load combinations including Earthquake. Computation shall be based on the buoyant unit weight of the soil plus full hydrostatic pressure. The value of δ shall be taken as half the value of δ for dry backfill. The full upward pressure of water below basement floors shall be taken over the entire area.

m) Rain Loads

Design maximum intensity of rainfall for the roof is 160 mm/hr. The flat roofs shall be designed to sustain the load of rainwater that could accumulate on it during any unlikely event of roof drain blockage. The maximum accumulated height of water shall be assumed as 300mm over roof drain and 150mm over roof slab. Rain load and live load on roof shall not be considered to act simultaneously and more critical of the two shall

be adopted in the design.

n) Wind Loads

The design wind speed (Vz) shall be computed in accordance with BIS:875 (Part-3).

The relevant normal loadings to be considered in combination with wind load as stated above shall comprise of the full dead load and the reduced percentage of live loads as applicable, together with live loads on roof. For structural design 100 year return period of wind shall be considered.

o) Seismic Loads

Since no safety related systems are located in turbine building and other associated structures, but due to provision of MSIV on PCB, the seismic classification has been kept as NINS and structure design is to be done as per codal provisions of IS 1893.However, the structural integrity against collapse is also to be maintained for all the structures under the extreme loading (SSE) condition to ensure safety of the adjacent safety related buildings viz. Control Building, SAB etc.

The elements of the structures shall be checked considering the SRSS values of responses due to all the three ground motions acting concurrently.

At KAIGA 5&6 site, for SSE condition the digital value of Response spectra shall be given at a later stage.

The relevant normal loadings to be considered in combination with seismic load (SSE) shall comprise of the full dead load and the following percentages of live loads:

Load Class	Percentage of Design Live Load
Staircase & balconies	25%
Uniformly distributed live loads 4000 N/sq.m. and above	50%

Under earthquake conditions the structure shall be assumed as loaded with the above-reduced percentages of live loads and the roof with no live load . Self wt. of EOT cranes shall be considered without any lift load.

Active earth pressure distribution due to submerged backfill on the basement walls during an earthquake shall be as per the provisions of BIS:1893. Also active pressure due to uniform surcharge over backfill behind basement walls shall be obtained as per BIS:1893. For saturated earthfill, the saturated unit weight of the backfilled soil shall be adopted. For submerged earthfill, the dynamic increment in active earth pressure during earthquakes shall be found using Mononobe-Okabe formulae which has been furnished in of BIS:1893and also recommended in ASCE 4-16.

p) Crane Load:

The maximum load while lifting the test load shall be considered . However this shall not be considered during the seismic condition.

q) Surcharge:

Unless specified otherwise, a surcharge (Minimum 2 T/SQM) shall be considered in the design on account of movement of equipment, traffic, stacking of material , crane etc. on the ground adjacent to structures .

r) Internal Pressure (In case of Pressure Tunnels)

The internal water pressure in the tunnels including the surge & shut off condition shall be considered in the design appropriately as specified in Section C-2-5.

s) **Any Other Load:**

As applicable the load due to temperature, creep, shrinkage etc shall be considered in the design following the relevant codal provisions.

t) Combination Of Loads

The turbine buildings and other structures shall be designed for worst combination of the loads specified above and any other loads as applicable. The suitability of the design shall be checked for load combinations to satisfy the Limit state of serviceability & Limit state of strength / Collapse as defined below:

i) Limit state of Serviceability :

Load combinations under this category are unfactored (or as given in Table-18 , BIS:456 for Limit State of Serviceability) and shall be used to ensure the requirements of limit state of serviceability of the structure. For CCW Tunnels relevant requirements specified in the AWWA standards and requirements specified in C-2-5 shall be met.

ii) Limit State of strength/ Collapse:

Load combinations for design under this category are factored and shall be used to ensure that no applicable limit state of failure is exceeded and stresses in the structure are well within its permissible limits . The structural elements to grouped into a number of groups and the basic loading combinations applicable to each of these groups shall be applied . The load factors applicable for the various load combinations shall be based on the combination philosophy of BIS:456, except for the Extreme Environmental load combination. No load factors for extreme environmental load (SSE) combination has to be considered.

All loads with appropriate load combinations shall be considered to act with the corresponding load factor. The most unfavorable effect on the structural element shall

be considered for design. In the load combinations, under Severe Environmental and Extreme Environmental condition, the earthquake and the wind loads are considered not to act concurrently. Moving loads such as those of monorail hoists, EOT crane together with the loads lifted are considered only for normal load combinations. In other combinations their static load effects without the loads being lifted are to be considered. Loading effects due to truck or transformer movement are to be considered under normal load combination. Construction load shall be combined with dead load only.

For CCW Tunnels relevant requirements specified in the AWWA standards and requirements specified in C-2-5 shall be met.

2.4 Submission of design report

The analysis shall be carried out using NISA, ANSYS, ABAQUS, SAP, which has been validated. The bidder shall make copies of all the analysis & design documents available to the owner in required numbers as desired by the purchaser.

2.5 ANALYSIS AND DESIGN

Prior to carrying out actual analysis, the structural analysis software needs to be validated by solving some benchmark problems.

2.5.1 F.E. Modelling & Design of Turbine Building, Electrical Bay, PCB, Access Bridge &Transformer Yard

The structures should be idealised as a 3D framed system. Raft, Pile(if applicable) Columns, beams and slabs should be modeled using suitable finite elements available in the structural analysis software to be used. Commercially available software for structural analysis like NISA, ANSYS, ABAQUS, SAP etc.

3D static analysis has to be done to obtain the member forces due to the static load conditions.

To obtain the member forces due to earthquake, response spectrum analysis with 3-D model of the structure has to be performed using the response spectra as per IS 1893. For collapse study under SSE, the response spectra shall be given at a later stage.

2.5.2 TG BLOCK

The TG block consists of top deck, columns, intermediate platforms and TG mat. Top deck supports the turbine, generator and the exciter. The columns of TG pedestal, independent columns supporting the platforms, some internal columns and pit walls are supported on the TG mat.

The design of TG block shall be based on working stress method. The permissible stresses in concrete and reinforcement shall be based on IS: 456 and IS: 2974 (part-3). In addition to functional requirement mentioned above codal requirements of IS: 2974 (Part-3) shall be satisfied. Some of the important requirements are listed below:

- The base mat shall be so dimensioned that the resultant force due to weight of the machine, the top deck, intermediate floors/platforms, columns supporting the TG deck, equipments and supporting structures resting on mat, basement walls resting on the mat etc., shall not have eccentricity with respect to the centre of gravity of the base area more than 3% of the base dimensions in the direction of the eccentricity.
- Adequate haunches shall be provided at intersections of the beams and the columns to avoid large concentration of stresses and to increase general rigidity of the frame.
- Fundamental natural frequency of the TG block in horizontal direction shall be separated by a minimum of 20% of the operating speed and fundamental natural frequency in vertical direction shall be separated by 50%.
- Minimum reinforcement for the deck beams shall be 0.25% of the sectional area at top and bottom and 0.1% of sectional area at sides.
- Allowable bearing pressure on soil/rock shall be 80% of allowable safe bearing pressure on soil
- For grouting of machine bed plates and pockets for anchor bolts, non-shrink grout shall be used.
- TG block should have adequate strength to withstand the worst combination of static, dynamic and seismic loads.
- Raft should be rigid enough to ensure fixed end conditions for the columns and prevent non-uniform settlement. If required , the Piles shall be provided under the raft.
- The natural frequency of the machine foundation system to be such as to avoid resonance at operating speed of the turbo-generator and the amplitude of displacements or any other specific criterion specified by the Turbine / Equipment Manufacturer.

2.5.3 Tunnel Trenches

The Tunnels are to be designed for the worst combination of loads considering Internal water pressure , wherever applicable (Considering Surge both positive & negative pressure & Shutoff Pressure), Earth Pressure (considering fully saturated soil conditions) , Surcharge, Seismic Loads, Loads from vehicular movement over tunnels and any other additional loads etc. as applicable. The support for tunnel shall be properly modeled considering the springs or any other elements as the case may be. The suitability of design shall be checked for completely filled as well as in its empty condition etc. also.

The tunnels are to be designed meeting requirements specified in IS 3370 .

2.5.4 SPECIFIC REQUIREMENTS

2.5.4.1 FIRE RATING & CORROSION

The Turbine building& other associated structures in the scope of this tender will have to cater the fire rating specified in Section C-1-3, unless approved otherwise. The following minimum dimensions and clear covers shall be provided.

Element	Parameter	Minimum Dimension (mm) for Resistance Period			
		1 hour	2 hour	3 hour	4 hour
Column	Side	200	300	400	450
	Cover	25	35	35	35
Load	Thickness	125	150	200	250
bearing	Cover	15	25	25	25
wall					
Slab	Thickness	100	125	150	175
	Cover	15	25	35	45
Beam	Width	125	200	250	275
	Cover	30	60	70	80

Note: Covers indicated relate to main reinforcing bars. Floor finishes shall be taken as part of clear cover for top reinforcement in beams and slabs . Fire rating requirements will not govern for secondary structural elements like lintels, transoms, mullions and canopies. Weld mesh shall be provided wherever cover is more than 40 mm.

2.5.4.2 EMBEDDED PARTS (EP)

These shall be designed for maximum forces arising out of Operating condition and Earthquake (codal) condition**.** It may be noted that the usage of Cinch anchors for anchoring any equipment is prohibited unless specifically permitted by the engineer. Therefore the bidder should provide adequate number of EPs for fixing the equipment and services. However, anchors less than 6 mm dia may be used to provide electrical fixtures etc.

3. CLEARING AND EXCAVATION

3.1 GENERAL

SCOPE OF WORK :

The excavation of site will be carried out within the terminal points of this package by the Purchaser as indicated in the drawing no KAIGA 5&6/16000/2003 /SK. However, additional excavation, if any required from functional reasons due to system requirements or due to geotechnical reasons , shall be carried out by the contractor at his own cost. Wherever, the founding levels are lower than the levels specified in above drawing the ground shall be lowered by bidder using appropriate cutting tool like , rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. The over excavated / damaged improved ground, if any, shall be made good by the bidder at his own cost. Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure. Contractor shall make necessary arrangement for Dewatering alongwith stand by arrangement at his own cost. The contractor has also to make necessary arrangements for side protection to avoid any slippage of rock/ soil etc. at his own cost. No extra payment will be made to remove any of slipped rock/earth etc in the excavated area. The contractor is also requested to visit the site prior to quoting & satisfy himself with the actual site conditions. In case further excavation is required, the same shall be carried out as per following specifications.

A) This section covers all the excavation works to be performed under this contract which shall consist of clearing of site and excavation of all existing material of whatever nature, to the lines and grades shown on the construction drawing or as otherwise directed by the engineer. The work shall also include drilling and blasting, loading, hauling and disposal of materials in designated spoil, stockpile areas or directly as construction materials.

B) The contractor shall also be responsible for excavation which is not specifically required for the construction of permanent structures, but incidental to the installation of temporary facilities such as site roads, approach ramps etc.

C) Slope protection and stabilization measures, which may be needed in conjunction with surface excavation work, shall be carried out as defined in other sections of these specifications.

D) The approval given by the Engineer during the course of execution, to the contractor's methods and equipment shall not relieve the contractor of his full responsibility for the proper and safe execution of excavations, or of liability for injuries to, or death of persons, or any other obligations under this contract. It shall also not relieve his

responsibilities for the accuracy or adequacy of the plan for obtaining the desired results in the stipulated time schedule.

3.2 SUBMITTALS

A) The contractor will be required to submit along with the bid, a detailed method statement, drawings and work programme for the excavation. The method statement has to give the details on the plant and equipment proposed to be used by the contractor for excavation and haulage, blasting methods, drainage and safety precautions, disposal of material, procedures for installation of rock supporting and stabilization works, and for construction of temporary site facilities such as roads, temporary drainage lines etc.

B) After the award of work and at least 15 days prior to commencement of the actual excavation, the contractor shall submit to the Engineer an updated method statement and programme for the activities set out in (A) above giving refined and full details of the proposed excavation methods in soil as well in rock and sequences including necessary plans for site drainage and safety precaution. Any and all variations from the corresponding data submitted with the tender will be explained and justified in the updated document to the satisfaction of the Engineer. The data shall include the following:

i) Method for excavation in soil & soft rock
ii) Location and area of blast
iii) Diameter, spacing, depth, pattern and orientation of blasting holes
iv) Type, strength, amount, column load and distribution of explosives to be used per hole, per delay and per blast.
v) The type of detonators, powder factor and sequence and pattern of delays to be used for blast.
vi) Description and purpose of any special methods of equipment to be adopted by the contractor.
vii) Type & No. of PPV measuring equipments along with methodology of measurements.
viii) No. of blast per day.
ix) Method of mucking & disposal of excavated material.
x) Details of the equipment to be deployed with proper justification.

C) Within 7 days of receipt of the above updated excavation method statement and programme, the Engineer will advise the contractor in writing, of his acceptance of, or comments on the submitted documents. The Engineer reserves the right to reject the proposed plan, if, in his opinion, undesirable damage to permanent rock surfaces or existing structures would result from the proposed blasting action. If acceptance is withheld, a new plan in whole or in part shall be submitted. Excavation shall only be carried out in areas for which the Engineer has accepted the plan.

D) At least 15 days prior to dumping and stock piling any excavation material, the contractor shall submit the layout of spoil or stock pile areas which will be within the areas designated on the tender drawings or as approved by the Engineer. All pertinent data of working methods and provisions for stability and temporary and permanent

drainage of the areas shall be included. Details of volume proposed to be stored, material types, heights of storage and grades shall be provided.

E) The Contractor shall submit and agree with the Engineer a monitoring plan for the progress of the excavation as well as to observe potential or actual movement of the slopes of the excavated pit. This plan shall also give details of the procedure and equipment to be employed by the contractor to stabilize or to protect as quickly as possible any areas in which untoward movement or slope deformation is likely to occur or has occurred.

3.3 CLEARING THE SITE

All the areas upon which the construction is to be carried out and over which excavation is to be done and areas which are required by the Contractor for his construction facilities are to be cleared of all rubbish, stumps, roots, bush, vegetation etc. and any other objectionable matter. Stumps, roots shall be removed to the full depth wherever possible but at least 450 mm below original ground level. Trees, if any, shall not be uprooted or cut without the prior approval of the Engineer. All spoils and unserviceable materials and rubbish shall be disposed of at locations away from the work site in a manner directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction. Useful materials, saleable timber, firewood etc., shall be stacked properly at the work site in a manner directed by the Engineer and finally handed over to NPCIL.

3.4 LAYOUTS AND LEVELS

Under no circumstances shall the contractor remove or disturb any permanent benchmarks / reference pillars installed by NPCIL. The contractor shall carefully maintain and protect all benchmarks and reference pillars and shall layout all his works by accurate reference thereto. The layout and levels of all structures shall be made by the Contractor from the general grid of the plot and bench marks given by the Engineer. The Contractor shall make his own surveying arrangements for laying out and establishing the reduced levels based on two reference grid lines and one bench mark as furnished by the Engineer and shall be responsible for the accuracy of layout and levels.

The theodolite and leveling instruments to be used by the Contractor shall be of digital type (total station). He shall also render necessary assistance to the Engineer by way of surveying instruments, materials and men for checking the layout and levels.

The ground level shall generally be taken at spacing at a grid of 5m x 5m.Where local mounds or abrupt undulations are met with or when so directed by the Engineer, the grid spacing may be at closer interval not exceeding 2m. The ground levels shall be properly recorded and plotted on plans, which shall be signed by the Contractor and the Engineer before the earthwork actually commences.

3.5 EXTENT OF EXCAVATION, LINES AND GRADES

The contractor shall perform excavation in all types of soils, murrum, soft and hard rock, boulders etc. in foundation, over areas and in trenches to widths, lines, levels, grades and curves as shown in the drawing or to lesser widths, lines and levels as directed by the Engineer. The Contractor shall clear the following work areas required for the performance of the work:

- Area of buildings / structures covered under the scope of this contract.
- All areas where backfill or grading as specified, including stacking yard and disposal areas as well as road formations within the points as specified in the drawings.
- Areas proposed to be occupied by Contractor for his plant and machinery, offices and camps.
- Any other area specified by the Engineer.

3.6 APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to:

a) IS-3764 - Safety Code for Excavation Work.

b) IS:9758 - Guidelines for de-watering during construction.

c) IS:10379 - Code of practice for field control of moistures and compaction of soils

d) Indian Explosives Act 1940 (Latest Version)

e) IS-2720 - Part-II - Determination of water content.

Part-VII - Determination of water content. - Dry Density Relation Using Light Compaction.

Part-VIII - Determination of Moisture content - Dry Density Relation Using Heavy Compaction.

Part-XXVIII - Determination of Dry Density of Soils, In-place, by the Sand Replacement Method.

Part XXIX - Determination of Dry density of Soils, In place, by core cutter method.

f) IS-4081 - Safety Code for Blasting and Related Drilling Operation.

g) IS-1200 - Method of Measurement of Building Works.

3.7 EARTHWORK EXCAVATION -GENERAL

Excavation shall be done to lines and levels defined in the drawings or as directed by the Engineer. *A drawing indicating the bore logs is attached in the tender*. The earthwork shall also include, where required temporary sheet piling or sheeting, bracing and shoring, to maintain the excavated pits, without interruptions to service lines, cables, duct banks, etc., encountered within the area of excavation or within reasonable distance of excavation.

3.7.1 LIMITS OF EXCAVATION

All excavation shall be carried out very carefully using methods and techniques that will produce smooth and sound rock surfaces with minimum over-break and fracturing beyond the lines and grades/ limit of excavation shown in the construction drawings and will preserve the structural integrity of the excavated area. The contractor shall take all precaution to preserve in the soundest possible and undisturbed condition all materials beyond the limits of excavation. Special care shall be exercised where vertical or near vertical faces are required. The excavation of final 150 mm thick layer shall be carried out with special care as directed by the Engineer, to ensure that the there are no major protrusions and major over cuts. In rock excavation, an over break limit of 150 mm in local spots may be allowed only on sides. Any extra excavation shall be made good by the contractor at his own cost with the class of material proposed to be laid over it or any other material approved by the Engineer.

Soft pockets, if any, shall be removed even below the final level and extra excavation shall be filled up by material which is proposed to be laid over it or any other material approved by the Engineer.

3.7.2 CLASSIFICATION OF EARTH WORK

For purposes of work to be executed in accordance with this specification, the following classification shall apply.

A) All types of soils, murrum, loose boulders of size with volume up to 1 cum, intrusions and soft rock
B) All types of rock and boulders with volume beyond 1 cum.
C) Dental Excavation

The excavation work shall further be categorized in the following 3 categories:

A) Excavation in General Areas & grading work up to grade level.
B) Excavation for buildings /structures foundations below grade level.
C) Excavation for Tunnel & trenches etc., below grade level

3.7.3 EXCAVATION IN SOIL

This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof, soft and hard murrum, shingle etc. which is loose enough to be removed with spades, shovel, pick axes, poclain & poclain mounted rippers. Boulders in all volumes up to 1 cu.m, found during the course of excavation shall also fall under this classification. This shall also include all materials, hard conglomerate, all decomposed weathered rock, highly fissured rock and other varieties of soft rock, which can be removed with pick axes, crowbars, wedging and hammering & other mechanical equipment with some difficulty. The mere fact that the contractor, for reason of his own, resorts to blasting and/or wedging and chiseling for excavation shall not mean the rock is classifiable as hard rock.

When the bottom of the excavated pit as indicated in the construction drawing is disturbed or loosened by the excavation process, the contractor shall improve it at his own cost with the class of material proposed to be laid over it or any other material approved by the Engineer.

3.7.4 EXCAVATION IN HARD ROCK

This includes all rock other than materials mentioned above, occurring in masses, boulders having approximate volume more than 1 cum., which can best be removed only by blasting, hydraulic splitting, chiseling and wedging (where blasting cannot be permitted owing to any restriction at site). The total excavation work in hard rock shall be categorized in the following 4 categories:

a) Excavation in hard rock using general and free blasting
b) Excavation in hard rock using controlled blasting
c) Excavation in hard rock by blasting using mufflers (muffled blasting).
d) Excavation in hard rock without blasting i.e. by wedging / barring / hydraulic splitter.

3.7.5 STRIPPING BLUFFS AND LOOSE ROCK

All loose boulders, semi-detached rocks not directly in the excavation but 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, or 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 likely to later become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

3.7.6 APPROACH RAMPS/ROADS

The contractor shall adopt method of mucking by clamshell, dragline or conveyors. However only under exceptional circumstances where ramps are unavoidable, the Contractor may provide the same with the prior approval of the Engineer. Berms, if

required at intermediate levels may be provided beyond 6-m depth with the prior approval of the Engineer. Such ramps shall be excavated later and the excavation shall be finished to the lines and grades shown on the approved drawings and to the satisfaction of the Engineer. No extra payment shall be made for formation of such berms , ramps etc. The berms , ramps falling outside the line of excavation shall be made good after the completion of work as directed by the Engineer.

3.8 STABILITY OF EXCAVATION

The methods of excavation shall, in every case be subject to the approval of the Engineer. The Contractor shall ensure the stability and safety of the excavations, adjacent structures, services and the works. The Contractor shall ascertain himself the nature of materials to be excavated and difficulties likely to be encountered in executing the excavation. Coffer dams, sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided and installed by the contractor. The contractor shall submit drawings to the Engineer showing the proposed arrangement with detailed design calculations and shall obtain written approval from the Engineer. Irrespective of the approval of the Engineer, the responsibility for adequacy of such measures shall rest fully with the contractor.

If any slip occurs, the Contractor shall remove all the slipped material from the excavated pit, at his own cost. Also, if any damage to the built up structure occurs because of the slip, the Contractor shall make good the same at his own cost & to the satisfaction of the Engineer.

3.8.1 TIMBER SHORING

Timber shoring shall be as specified in IS: 3764-Safety Code for Excavation Work. Wherever the shoring is required for deep excavations, the same shall be designed by the Contractor and got approved by the Engineer prior to its use in the work

Timber shoring shall be 'Close' or 'Open' type, depending on the nature of soil and the depth of pit or trench. The type of shoring shall be as approved by the Engineer.

3.8.2 OPEN TIMBERING

In the case of open timbering, the entire surfaces of the side of trench or pit are not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangements, sizes of the timber and the spacing shall be subject to the approval of the Engineer.

3.8.3 CLOSE TIMBERING

Wherever so directed by the Engineer the contractor shall provide close timbering

3.8.4 LEFT IN SHORING

If the Engineer directs any timbering to be left in for the safety of the structure or otherwise for reasons commensurate with the type of construction, necessitating such decision, the same shall be provided by the contractor.

3.8.5 REMOVAL OF SHORING

The removal of shoring timber shall be done very carefully to prevent the collapse of the pit or trench. It shall start at one end and proceed systematically to the other end. No part of the work should be damaged during the removal of the shoring. No claim shall be entertained for any shoring, which cannot be withdrawn and is lost and buried.

3.9 EXCAVATION IN HARD ROCK

Excavation in hard rock shall generally be carried out by blasting. If, due to proximity of structures or due to other reasons, blasting is not possible or permission for blasting is refused by the Engineer, the excavation shall be carried out by chiseling, wedging, picking, barring, hydraulic splitting, burning & sudden quenching or by other approved methods.

3.10 LINE DRILLING

Where shown on the drawings or specified by the Engineer, vertical faces of excavations shall be formed by line drilling. Line drilling is defined as a single row of unloaded holes drilled along the excavation line, spaced no more than 2 to 4 times the hole diameter on the centers.

The diameter of the holes for line drilling shall be 50 mm or more. The maximum spacing of the holes shall be 150 mm when the diameter of the hole is 60 mm or less. When the line-drilled holes are greater than 60 mm in diameter, the spacing of the holes may be increased suitably by conducting suitable mock-ups wherein the diameter of the hole and spacing may be varied to arrive at suitable spacing. No additional payment shall be made for such mock-ups.

All vertical faces shall be line drilled to prevent damage to the rock beyond the limits of the excavation. The blast holes directly adjacent to the line drilled holes shall generally be loaded with less amount of blasting material and shall be closely spaced than other holes in the primary pattern. The distance between the lines drilled holes and the directly adjacent blast holes shall be 50 to 75 per cent of the normal burden..

3.11 PERIMETER DRILLING AND PRE-SHEARING

Where shown on the drawings or specified by the Engineer, vertical faces of excavation shall be formed by perimeter drilling and pre-shearing to the dimensions shown on the drawings. Within 1 m of corners, the hole spacing shall be reduced by drilling intermediate holes so that satisfactory and high quality excavation lines are maintained at corners. These intermediate guide holes may or may not be loaded.

The Contractor shall carry out trials prior to commencing actual perimeter drilling and pre-shearing to determine the correct spacing of the drill holes and amount of explosives required per hole to permit the rock to shear cleanly between the holes.

The spacing of holes may vary from 300 mm to 750 mm depending on the rock characteristics and the amount and type of explosives placed in the holes, so that the rock will break cleanly between the holes with a minimum of shattering of rock on the exterior faces of the excavation. Such experimental blasting shall not be separately paid for.

All pre-shearing of vertical faces shall be carried out by the Contractor prior to blasting the interior pattern holes of the excavation so that a sheared line will be established on all vertical faces around the perimeter of the excavation. Perimeter drilling and pre-shearing shall be carried out to the full depth of the vertical faces of the excavation.. If, the depth of excavation exceeds 6m, the pre-shearing may be done in stages subject to the approval of engineer & without any extra cost.

3.12 DENTAL EXCAVATION

A) Dental excavation shall include the removal of unsuitable materials from shear zones, clay seams, pockets, joints or from spaces between boulders beyond the lines of excavation shown on the construction joints which are too small to be excavated by common earth moving equipment.

B) Dental excavation, depending upon its extent will require the use of back-hoe or other small excavating equipment as well the use of high velocity air water jet. The methods deployed shall be such as to avoid fracturing of the adjacent rock.

Where directed by the Engineer, the contractor as stipulated above shall carry out dental excavation. The extent to which such materials shall be removed including depth, direction and other dimensions will be determined by the Engineer. In general, depth shall be more than the width of the seam. Dental excavation shall not be carried out by blasting. Such excavated pits shall be backfilled with concrete or shotcrete as decided by the Engineer..

3.13 BLASTING

A valid blasting license shall be obtained by the Contractor from authorities concerned for starting any blasting work. The Contractor shall employ a competent and experienced supervisor (called Man-in-Charge) preferably having experience in mining operation and licensed blaster. They shall be held personally responsible to ensure that all safety regulations are followed.

Before any blasting is carried out, the Contractor shall intimate the Engineer and obtain the written approval of the Engineer & safety officer of NPCIL for resorting to blasting operations. Contractor shall intimate the hours of firing charges, the nature and quantum of explosives proposed to be used. Blasting shall generally be carried out at

certain specified hours preferably early morning, during mid-day lunch time and/or at the close of work before sunset. The hours when blasting will be carried out shall be made known to people in the vicinity. In general, the contractor shall resort only to electric blasting and shall use dynamite or gelatin sticks.

Before starting blasting, the area shall also be encircled by red flags planted 200 m from the zone of blasting. All persons including workman shall be evacuated from the encircled flagged area at least 10 minutes before firing. A warning whistle/ siren shall be sounded for this purpose. The Contractor shall be responsible for any accident to workmen, public or property due to unsafe blasting operation.

3.13.1 EXPLOSIVES

The Contractor shall acquaint himself with all the laws, and regulations concerning, purchasing, transporting, storing, handling and use of explosives. All such laws, regulations, rules and safety codes, etc. as are prevailing from time to time shall be binding on the Contractor.

The provisions detailed in this specification are supplementary to the above laws, rules and regulations. Further, the Engineer may issue modifications, alterations and new instructions from time to time.

All materials such as explosives, detonators, fuses, tamping materials etc. that are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

The Engineer may render necessary help to the Contractor to obtain license for explosives. However, it is the Contractor's responsibility to obtain the license, paying the necessary fees etc.

Gelatin, Dynamite, ANFO and such other safe explosives shall only be used wherever possible. Explosives with nitroglycerine shall be used only under exceptional circumstances with prior approval of the Engineer.

The Contractor shall clearly indicate the type and grades of explosive, he proposes to use for blasting for different type of work under different conditions and the same shall be approved by the Engineer before commencement of work. Special gelatin 80% and open cast gelignite are the explosives recommended for most type of excavation. In damp rock, high explosives like special gelatin shall be used. Where especially hard rock is encountered or exceptionally good fragmentation is required, special Gelatin 90% may be used.

For initiation, electric detonators (instantaneous and short delay), ‘Cordtex’ Detonating Fuse and detonating relays may be used. Electric short firing is preferred.

The detonators used shall be capable of giving effective blasting of the explosives. All the damaged detonators shall be discarded.

The explosives shall be exploded by means of a primer, which shall be fired by a fuse instantaneous detonator (FID) or other approved cables. The detonators with FID shall be connected by special nippers.

3.13.2 STORAGE OF EXPLOSIVES

The Contractor shall have to make necessary storage facilities for the explosives as per rules of the local authorities and the Govt. of India.

The Contractor shall build a magazine for storing the explosives. The site of the magazine, its capacity and design shall be subject to the approval of the Engineer and the Inspector of Explosives before the construction is taken up. As a rule, the explosives shall be stored in a clean dry, well ventilated, bullet-proof and fire-proof building at an isolated site as approved by the Engineer / Inspector of explosives.

The explosives, detonators and fuses shall each be separately stored in accordance with relevant Govt. rules.

3.14 MAINTENANCE OF EXPLOSIVE MAGAZINE

The Contractor shall keep a careful and day-to-day account of the use of explosives in an approved register and in an approved manner. The register shall be produced by the Contractor for inspection of the Engineer whenever so required by the latter. The Engineer may also pay surprise visits to the storage magazine. In case of any unaccountable shortage of the explosives or if the account is not found to have been maintained in a manner prescribed by the Engineer, the Contractor shall be liable to be penalized. The action taken under this clause shall be in addition to that, which might be taken by the competent civil authorities in a court of law.

The magazine shall, when not in use by authorised person, be kept well and securely locked and guarded.

The magazine shall at all times be kept scrupulously clean. No unauthorised person should at any time be admitted inside the magazine.

The magazine shall not be opened during or on the approach of thunderstorm and no person shall remain in the vicinity of the magazine during such periods. Magazine shoes without nails shall, at all times be kept in the magazine and a cement trough 30 cm high and 45 cm. in diameter, filled with water shall be kept near the door of the magazine. Persons entering the magazine must put on magazine shoes, which shall be provided by the Contractor for the purpose. They will also:

1. Not put their feet on the clean floor unless they have the magazine shoes on.

2. Not allow the magazine shoes to touch the ground outside the clean floor.

3. Not allow any dirt or grit to fall on the clean floor.

Person with bare feet shall, before entering the magazine, dip their feet in water and then step direct from the tub over the barrier (if there be one) on the clean floor. A brush or broom shall be kept in the lobby of the magazine, for cleaning out the magazine on each occasion it is opened, for the receipt, delivery or inspection of explosives.

Matches, lighters or inflammable material shall not be allowed inside the magazine. Light shall be obtained from an electric storage battery lantern

No person having articles of steel or iron on him shall be allowed to enter the magazine.

Oily cotton rags waste and articles liable for spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles.

No tools or implements other than those of copper, brass, gunmetal, or wood shall be allowed inside the magazine. All tools shall be used with extreme gentleness and care.

Boxes of explosives shall not be thrown down or dragged along the floor, and shall be stacked on wooden trestles. Where there are white ants, the legs of the trestles should rest in shallow copper, lead or brass bowls containing water. Open boxes of dynamite shall never be exposed to the direct sun rays.

Empty boxes or loose packing material shall not be kept inside the magazine.

The magazine shall have a lightning conductor, which shall be got tested at least once in six months by an officer authorised by the Engineer. The Contractor shall, within 15 days, comply with all recommendations made by the officer testing the lightning conductor.

A notice shall be hung in the lobby of the magazine, prohibiting entrance of unauthorised people.

The following shall be hung in the lobby of the magazine:

a) A copy of rules both in English, Hindi & in the language which the workers concerned is familiar with.

b) A statement showing the stock in the magazine at the particular time.

c) The certificate showing the last date of testing of the lightning conductor, and

d) A notice that smoking is strictly prohibited.

The magazine shall be inspected at least twice a year by an officer representing the engineer, who shall see that all the rules are strictly complied with. He shall notify all

the omissions to the Contractor who shall rectify the defects within a period of 15 days from the date of receipt of the notice.

3.15 TRANSPORT OF EXPLOSIVES

For the transport of the explosives and detonators between the store and the site, approved mobile explosive van shall be used.

3.16 DISPOSAL OF DETERIORATED EXPLOSIVES

All deteriorated explosives shall be disposed of in an approved manner. The quantity of the deteriorated explosives to be disposed off shall be intimated to the Engineer, prior to its disposal and record thereof shall be maintained.

3.17 PERSONNEL

Excavation by blasting will be permitted only under the personal supervision of approved competent person and licensed blasters having minimum five years of mining experience and trained workmen.

All supervisors and workmen in charge of make up, handling, storage and blasting work shall be adequately insured by the Contractor.

Storage shall be, handled by a very reliable person approved by the Engineer. The Engineer may, if necessary conduct police inquiries as to his reliability, antecedents etc. The Contractor shall have to produce a security for the person in-charge of the explosives, if and when required by the Engineer, or to the civil authorities of the district.

The Contractor shall make sure that his supervisors and workmen are fully conversant with all the rules to be observed in storing, handling and use of the explosives. It shall be ensured that the supervisor in charge is thoroughly acquainted with the details of handling of explosives and blasting operations.

3.18 PREPARATION OF PRIMER

The primers shall not be prepared near open flames or fires. The work of preparation of primers shall always be entrusted to the same personnel involved in blasting and shall be supervised by the respective shift supervisor. Primers shall be used as soon as possible after they are ready.

3.19 CHARGING OF HOLES

Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock muck produced due to blasting can be handled without necessity of secondary blasting. Pattern of drill holes shall be got approved by the

Engineer. The work of charging shall not commence before all the drilling work at the site is completed, and the supervisor has satisfied himself to that effect by actual inspection.

While charging, open/naked lamps shall be kept away.

Only wooden tamping rods, without any kind of metal on them, shall be allowed to be used. The tamping rods shall have cylindrical ends. Bore holes must be of such a size that the cartridge can easily pass down the hole.

Only one cartridge shall be inserted at a time and gently pressed home with tamping rod - sand or clay or other tamping material used for filling the rest of the hole shall not be tamped too hard.

3.20 BLASTING OPERATIONS

Under all conditions of excavation, explosives like gelatin with detonator shall be used. In under-water or excavation with substantial seepage causing accumulation, an electric detonation shall be used.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting. The pattern and orientation of drilled holes shall be such as to prevent flying of rock pieces. The inclination of the holes shall be towards the non-developed/ unpopulated area of the site. The pattern of drilled holes shall be approved by the Engineer.

The blast material shall be of best make and as approved by the Engineer before actual use. Quantity of charge, spacing of holes, depth of holes etc. shall be determined based on suitable mock ups. The depth of hole may generally be 1.5 m but shall not exceed 6 m. The diameter of the hole may vary from 30 to 100 mm and the spacing of holes may vary from 1.2 m to 1.8 m in both directions.

When the drilled hole encounters water, the charge shall be fed into a steel tube or a plastic tube and inserted to the bottom of the hole.

3.21 CONTROLLED BLASTING

Where shown on the drawing or specified by the Engineer as a part of controlled blasting line drilling and or pre-shearing, may also have to be adopted for reducing over break and for preventing damage to rock beyond the limits of excavation. As a part of control blasting the PPV limitations given in clause 3.23 & 3.24 shall be followed. Wherever specified or directed by Engineer, to avoid the flying of stones, following protective measures must be followed while blasting.

3.22 PROTECTIVE MEASURES

Wherever specified and as directed by the Engineer, the following protective measures shall be adopted while carrying out blasting operations (under muffled blasting) to avoid flying of stones :

a) The hole shall be covered with 0.6 to 1.0 sq.m., mild steel plate of minimum 6 mm thick.

b) Reinforcement rod mesh not less than 20 mm dia. at 150 mm centers in both directions shall be placed over the steel plates.

c) Steel plate and reinforcement shall be inspected after every blasting operation and all twists shall be removed to the satisfaction of the Engineer before reuse.

d) Sand filled bags shall be placed over the mesh suitably covering the whole region under blasting operation.

e) The thickness of covering plate and the kind of dead weight is to be duly approved by the Engineer.

3.23 CONTROL IN BLASTING

In order to safeguard the existing civil structures and the operating power stations / units of DAE, the following limitations shall be taken note of by the Contractor while planning for excavation in hard rock. Measurement of ground vibration is required during the experimental blasting as well as actual excavation to ensure that the prescribed safe vibration level is not exceeded through out the excavation work.

a) The contractor shall arrange to provide engineering seismographs (such as seismograph model VS1600 or equivalent), sensors and such electronic devices to record the induced blast vibration in three mutually perpendicular directions to assess and monitor the impact of the blast on the adjacent structures and for carrying out suitable adjustment in the quantum of charge to prevent any damage to existing structures. The type/ model and quantum of seismographs proposed to be deployed shall be got approved by the Engineer. This shall be at no extra cost to NPCIL.

b) Delay detonators of 500 Millie second are recommended to be used for excavation.

3.23.1 CHARGE LIMITATIONS : GENERAL

Within 20 meters from existing structures, no blasting shall be done without prior written approval of the Engineer. It is generally recommended that where the blasting is to be done, within 20 meters of the nearest point of permanent building, the area shall be line drilled on periphery before blasting.

The peak particle velocity on any structure of nearby operating power plant shall be limited to the following values:

a) 10 mm per second, for normal cases.

b) In critical cases, peak particle velocity of 3 mm per second is prescribed as a safe vibration level for buildings where electrical and electronic equipment are installed.

Note: *The following tables are the results of the test conducted by M/S CWPRS .The contractor shall carry out an Independent similar study at his own cost for KAIGA site , unless approved otherwise by the Engineer. No extra claim in this regard will be entertained.*

Table A : Site specific safe charge weight, distance and PPV data for KAPP site.(for guidance only)

Distance (m)	**Safe charge weights/ delay (kg) for PPV of**	
	10 mm/s	**3 mm/s**
20	0.6	0.1
30	1.3	0.3
40	2.4	0.5
50	3.7	0.7
60	5.3	1.0
70	7.2	1.4
80	9.4	1.8
90	11.9	2.3
100	14.7	2.9
150	33.0	6.4
200	58.8	11.4
250	91.9	17.9
300	132.3	25.7
350	180.0	35.0
400	235.0	45.7
450	297.7	57.8
500	367.5	71.4

** The peak particle velocity limitations on structure of project under construction are as follows:

a) The PPV limits of above clause 3.23.1 b) shall be followed, for the structure where construction is completed & equipment are commissioned.

b) The PPV limits for the structures, which are under construction, shall depend as per the age of concrete. The charges given in 3.23.2 may be followed for the same after prior approval.

Contractor shall submit his scheme with charges and delays he proposes to use for blasting for approval of the engineer. Contractor has to make experiments for the above delay in the presence of engineer to verify whether the charges and delays, he proposes to use are suitable for the type of work. When blasting is necessary adjacent to partially or completely built structures, the contractor shall take all the precautions necessary to prevent damage to structures from the flying rock pieces. The contractor shall be responsible for all damages caused by blasting and shall replace or repair the structures at his own cost. All major blasting shall be completed prior to starting concrete work on site.

3.23.2 CHARGE LIMITATIONS : FOR GREEN CONCRETE

a) No blasting shall be allowed for any of the structure excavation until freshly placed concrete has reached a minimum strength of 7N/Sq.mm

b) Normally, blasting should be resorted to only after 7 days of concreting work in case of O.P.C. (10 days in case of PPC/fly ash concrete) in adjacent structures.

c) In no case, shall blasting be allowed closer than 20 m to any structure after concrete placing has started. When minor blasting is necessary after concrete placing has started in any structure, the maximum size of charge for distance from 20 meter and above shall be limited as per approved values.

d) The excavation of bottom-most 150mm thick layer shall be done by hand trimming, barring, chiseling, hydraulic splitting etc.

In case, barring, chiseling or hydraulic splitting cannot be resorted to for the last layer, Contractor, with the permission of Engineer may resort to controlled blasting with low charges. However, in case of over-break beyond the specified limits Contractor shall fill up the over excavated portions with same class of concrete as is proposed to be laid over the excavated portions or any other material approved by the Engineer, at his own cost. The choice of the filling material shall be at the discretion of the Engineer.

3.24 ELECTRIC BLASTING

Unless otherwise specifically approved by the Engineer, the Contractor shall resort only to electric blasting. Only approved make firing apparatus can be used on the job. The Supervisor in- charge shall only possess the key of the firing apparatus and he shall keep it always with himself. Special apparatus such as capacitor discharge blasting machine shall be used as a source of current for the blasting operations and power lines shall not be tapped for this purpose.

Before use, all the detonators shall be checked to ensure that they are not damaged. For blasting in series only detonators of the same manufacture and of the same group of electrical resistance shall be used. Such of the electrical lines as could constitute danger for work of charging, shall be removed from the site or shall be switched off. The firing shall be done with a proper insulating cover so as to avoid short-circuiting due to

contact with water, metallic parts or rock etc. The use of earth as a return line shall not be permitted. The firing cable shall be connected to the source of power only when nobody is in the area of blasting. Before blasting, the circuit shall be checked by suitable apparatus such as a blasting multi-meter of low output. After firing, whether with or without an actual blast, the contact between the firing cable and the source of current shall be cut-off before people are allowed to leave the shelter.

During storms, charging with electrical detonators shall be suspended. The charges already placed in the holes shall be blasted as soon as possible, but taking all safety precautions, and giving necessary warning signals. If this is not possible, the site shall be evacuated till the storm has passed.

3.25 PRECAUTIONS AFTER BLASTING

The name of the day & night shift Supervisors must be noted daily in the Contractor's office. After the blast, the supervisor must carefully inspect the work and satisfy himself that all the charges have exploded. After the blast takes place in underground works, the workman shall not be allowed to go to the place till all toxic gases have disappeared from the place.

If it is suspected that part of the blast has failed to fire or is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time should be allowed and then the supervisor alone shall leave the shelter to inspect the blasting zone. None of the drillers are to work near the misfired hole until one of the two following operations have been carried out by the Supervisor and no drilling in such holes of misfire shall be permitted

(i) The Supervisor should very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (using a pipe of soft material), and withdraw the fuse with primer and a fresh detonator with fuse should be placed in this holes and fired out, or

(ii) The hole may be cleared of 30 cm of tamping and the direction then be ascertained by placing a stick in the hole. Another hole may then be drilled at least 60 cms. Away and parallel to it and about 30 cms. Less in depth. This hole shall than be charged and fired. The balance of the cartridges and detonators found in the muck shall be removed.

(iii) Before leaving his work, the Supervisor from the previous shift shall inform the Supervisor of the relieving shift of any case of misfires and should point out the position with a red cross denoting the same and also stating what action, if any, he has already taken in the matter. The Supervisor should also at once report at the office of the Contractor and the Engineer, all cases of misfire, the cause of the same and what steps were taken in connection with the same.

(iv) If a misfire has been found to be due to a defective detonator or dynamite the whole quantity or box from which the defective article was taken, must be thoroughly inspected by the Contractor and if needed isolated.

3.26 ACCEPTANCE OF EXCAVATED AREA

Excavated area shall be cleaned, trimmed to exact shape and size. All disturbed material and other debris shall be removed and the surface shall be thoroughly cleaned to the satisfaction of the Engineer. A joint survey of the excavated pit shall be carried out at various stages of excavation such as soil and soft rocks and hard rock before acceptance of the excavated area. The joint survey report duly signed by NPCIL and the contractor. Before any further work with concrete or backfill is commenced, the Contractor shall inform the Engineer and get the area approved by him.

3.27 DISPOSAL OF SURPLUS MATERIAL

All surplus materials shall be carried away from the site and disposed at dumping site/ stock piles, in separate heaps as per the utility of the material, as directed by the Engineer. The Engineer may ask the contractor to dump the excavated materials in low lying areas, regular heaps, bunds, blankets riprap with regular slopes and level so as to provide natural drainage. As a rule, all softer material shall be laid towards the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. All such works as mentioned above are deemed to have been taken into account while quoting .

All excavated material from the pits shall be the property of the Corporation and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a rate fixed by the Purchaser, until unless specified otherwise.

In no case, the excavated soil shall be stacked within a distance of 1.5 m from the edge of the excavation or $1/3^{rd}$ of the excavation depth, whichever is more.

3.28 PRECIOUS OBJECT, RELICS, OBJECTS OF ANTIQUITY ETC.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or on the site shall be the property of the Corporation and contractor shall duly preserve the same to the satisfaction of the Engineer and from time to time deliver the same to such person or persons as the Engineer may from time to time authorize or appoint to receive the same.

3.29 DEWATERING ARRANGEMENTS

Wherever ground water table is met with, during excavation and also to take care of surface water running into the excavated areas, the contractor shall immediately bring it to the notice of the Engineer. The contractor shall adopt a detailed dewatering system and maintain dry working conditions by lowering the water table at least 1 m below the bottom of the excavation. The dewatering systems may be well point dewatering, open dewatering systems, deep well dewatering system or any other method suitable for the type of sub-soil/ strata. The Contractor shall prepare the detailed scheme for

dewatering in line with IS 9758 and submit the same to the Engineer for approval. The scheme proposed by the Contractor should take into account the disposal of water at a suitable location as directed by the Engineer so that the wastewater does not return back to the pit. The Contractor shall continue dewatering i.e. maintain dry working condition till the entire excavation is completed and until such time as directed by the Engineer. The Contractor shall remove all slush/ muck from the excavated area to keep the work area dry. The contractor may employ sludge pumps for this purpose.

3.30 USE OF EXCAVATED MATERIAL:

The Contractor may note that useful rock excavated from the structures shall be used for the production of fine & coarse aggregates & backfilling. All the rock excavated from the structure foundation suitable for aggregate production shall be subject to the approval of the Engineer and shall be stacked in the stockpiles at the locations directed by the Engineer. Similarly the material suitable for backfilling shall also be stacked suitably. The rock suitable for production of aggregates for concrete, if available shall be given to the Contractor at a rate fixed by KAIGA site. *However, the excavated material used for backfilling will be available free of charge, if required the contractor has to break the bigger sized available material to the suitable size as specified in the specification, for backfilling at his own cost* **.**

4. BACKFILLING

4.1 SCOPE

This specification covers the Backfilling around foundations in pits, trenches, plinth under floors & grade areas.

4.2 MATERIALS

a) Excavated soil & other suitable filling material obtained from site grading excavation and excavation for basements and foundations for various plant buildings is proposed to be used for filling, to bring the plant site to the designed finished grade level. Such filling material will be available to the contractor free of cost within the plant area, to the extent its availability and suitability for backfilling as decided by the Engineer.

b) Soils such as black cotton soil, clay and mixtures having swelling characteristics shall not be used for backfilling in plinth, the areas where structure are likely to be located, roads & below grade slab etc. However, such materials may be used in rest of the areas to make the same up to finished ground level (FGL) with the prior approval of the Engineer.

c) All clods of earth shall be broken or removed. Selected material from borrow pits, which shall be approved by the Engineer, can also be used for backfill.

d) The material from outside the plant boundary may also be used, after obtaining necessary approval of the source from the Engineer. Royalty, Taxes, Quarry fees etc, if any, shall be borne by the contractor and proof of payment thereof shall be submitted to the Engineer for record purpose.

e) No filling shall commence until dewatering upto a depth of 1 m below excavated level so as to enable the backfilling works to be carried in the dry condition as per the direction of the Engineer

4.3 BACKFILLING OF DIFFERENT AREAS

Backfilling of different areas shall be carried out as defined below:

a) **General area grading**: Backfilling shall be done using excavated material/ borrowed earth compacted in layers, with a limiting layer thickness of 300 mm.

b) **Area around trenches:** Backfilling shall be done using excavated material/ borrowed earth with a limiting layer thickness of 200 mm compacted to a thickness not more than 150 mm or by using Fill-crete as approved by the engineer.

c) **Plinth area and area around structure with available working space lesser than 3 m:** Where due to space constraint required compaction is not possible, backfilling shall be done with Fill-crete of minimum grade M-5 using cement, fly ash & sand mix (except for top 300 mm, which has to be filled with earth).

d) Under the foundation: Using PCC or Fill-crete as specified in the drawing

4.4 GENERAL AREA GRADING

a) Soil obtained from excavation shall be used for filling after breaking/crushing the clods of the soil. The water shall be added to bring the soil mass to optimum moisture content (derived from modified proctor density tests with varying moisture contents), rolled & compacted.

b) The lower layers of the fill shall be spread in uniform horizontal layers not exceeding the thickness specified in above clause in loose thickness and each layer shall be compacted with a minimum of 8 to 10 passes of a 10 Ton smooth wheeled vibratory roller. In this clause and all subsequent clauses, the 'Number of passes' shall mean the number of times that each point on the surface of the layer being compacted has been traversed by the roller. During rolling, the roller shall uniformly overlap not less than one third of the roller track width made in the preceding travel. Each layer of fill shall meet the specified compaction requirements given in the drawings, before any succeeding layer is placed. The top layer of finished thickness of 300 mm shall also be spread in one uniform horizontal layer and

compacted as above.

4.5 FINISHED COMPACTED SURFACE

The finished compacted surface of the top course shall be dressed to the slopes and cross falls indicated in the construction drawings and the finished surface shall not vary more than +/- 50 mm from the true elevation at any point.

4.6 PROTECTION OF FILLING

The contractor shall protect all fill and in the event of its being washed away by rainwater or damaged in any other way, he shall, at his own cost, restore and make it good. Should any slip occur, the contractor should remove the affected material and make good the slip with sound material without any extra cost to NPCIL and to the satisfaction of the Engineer.

4.7 FILLING OF TRENCHES

Filling in trenches for pipes and drains shall commence as soon as the joints of pipes and drains have been tested and accepted.

The filling on the sides of the pipe & up to 300 mm or diameter of the pipe, whichever is more, above the crown of the pipe shall be carefully filled with fine material such as selected earth / murrum etc. according to availability at site, in layers not exceeding 150 mm size watered, rammed & consolidated, taking care that no damage is caused to the pipes. In areas where mechanical compaction is not possible, fill crete shall be used as filling material.

4.8 FILLING IN PITS, PLINTH AND AROUND STRUCTURES

As soon as the area is cleared & approved, the space around the foundation structures in pits shall be cleared of all debris, brick bats, mortar droppings & waste concrete etc and shall be filled with earth, if the available working space is more than 3m, the earth filling shall be done in layers of thickness not exceeding the limits as specified above. Each layer shall be watered, rammed and properly consolidated to meet 90% of modified proctor density, before the succeeding layer is laid. Earth shall be rammed preferably with approved compaction machine. Usually no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as directed by the Engineer. At least one field density test by sand replacement method, as per IS: 2720 Part XXVIII shall be conducted on every third layer per 100 sq. meters to check the effectiveness of compaction. at no extra cost to Purchaser. The location for taking samples shall be randomly selected by the Engineer. Wherever compaction is not possible through mechanical means the same shall be filled using fill Crete/ fly ash or crusher dust /sand as directed by the Engineer.

4.9 SAND FILLING IN PLINTH AND OTHER PLACES

When directed by the Engineer, backfilling shall be carried out using selected coarse sand. The filled sand shall be flooded with water for sufficient time to ensure optimum consolidation. The surface of the consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures shall not be started until the Engineer has inspected and approved the fill. Compaction of sand will be determined as per IS: 2720.

4.10 GENERAL SITE FILLING BY BORROWED MURRUM

Murrum for general site filling shall be from approved source, which could be from outside the plant boundary limits. The approval for same shall be obtained from the Engineer.

4.11 USEFUL EXCAVATED MATERIAL

The Contractor may note that useful soil, excavated from the structures & foundations may be used for the backfilling or other suitable purposes if, permitted by the engineer. All the material excavated from the structure foundation suitable for use shall be subject to the approval of the Engineer and shall be stacked in the stockpiles at the locations directed by the Engineer. Similarly the material suitable for backfilling shall also be stacked suitably. The excavated material used for backfilling will be available free of charge, but if required the contractor has to break the bigger size material to the suitable size as detailed in the specification, suitable for backfilling without any extra cost. If adequate quantity of backfilling material is not available at construction site (through excavated material) the Contractor shall arrange the same from outside after prior approval of the source.

5. CONSOLIDATION GROUTING:

The structures shall be founded on competent strata. The consolidation grouting wherever required shall be carried out as per the following specifications.

5.1 APPLICABLE CODES

Unless otherwise specified, the following Indian Standard codes shall be applicable. In all cases, the latest revision of the Codes shall be referred to.

IS- 6066 -Recommendations for pressure grouting of rock foundations in River Valley Projects.

IS- 5529 Part-2- Code of practice for In- situ- Permeability Test –Part 2 Test in Bedrock

5.2 GENERAL PROGRAMME OF GROUTING

The number and pattern of grout holes (it includes primary, secondary and tertiary holes), spacing and depth of grout holes shall be as shown in the drawings or as directed by the Engineer. The pressure and proportion of grout mixes to be used for injection shall be based on water pressure test and the results of trial grouting operations. If the foundation conditions, as revealed by such tests, indicate that grouting to greater depth is necessary, the Contractor is required to drill to a greater depth and grout these holes at relatively higher pressure. If on the other hand, the drilling and grouting of primary holes indicate that the number and or the depth of secondary holes could be curtailed, the scope of work would get reduced. The holes, which absorb water greater than *3 lugeons*, shall invariably be grouted. (1Lugeon is water loss of 1 lit/m/min at a pressure of 10 kg/sq.cm.)

5.3 EQUIPMENT

5.3.1 DRILLING EQUIPMENT

All grouting holes shall be drilled at the locations and spacing, to the size & depths shown on the drawing or as desired by the Engineer. Percussion type drills, rotary type Tungsten Carbide/Diamond drills and if necessary large size drills, wagon drill etc., shall be used for drilling as appropriate for type of rock. For speedy drilling operation percussion drilling equipment, similar to Atlas Copco's standard O.D.Unit, may be used.

5.3.2 GROUTING EQUIPMENT

All equipment used for mixing and injecting grout shall be furnished by the Contractor. They shall be maintained in operating condition at all time.

The equipment for grouting purpose shall include, but not be limited to:

- Two air driven, double acting slush pumps of long stroke type capable of operating at a maximum discharge pressure of 10.55 kg/cm^2 (150 psi) with adequate bypass arrangement for circulating the grout.

- Pumping equipment of any other type, which is equivalent or better, may be used, with specific approval of the Engineer. The equipment shall be specially designed for grouting services including mixing, agitating, pumping and injection of a cement grout.

- Compressor with adequate capacity to deliver air at minimum pressure of 6.33 kg/cm^2 (90 psi).

- A mechanically operated colloidal (high speed) type mixer for preparing the grout.

- A mechanically agitated sump or hold over tank with provision for suitable screens to keep the mixed grout in suspension and remove hardened grout or foreign materials not passing through IS sieve with 1.18 mm standard screen. The

arrangement of these facilities shall be such that the gravity flow is ensured from the mixer to the agitator.

- A tank of sufficient capacity and with adequate by pass pipe and fittings for auxiliary water supply, to be used in pressure testing, flushing and pressure washing operations.

- Accurate water meter graduated in cubic meters and each cubic meter divided in five hundred parts with bypass so that water can be measured directly into the auxiliary water supply tank.

- Valves, pressure gauges including gauge savers, pressure hose pipes, fittings and such other small tools as may be necessary to provide a continuous supply of grout and also accurate pressure control. Pressure gauges shall be provided at grout pump outlet and at the grout hole manifold with a grout meter to measure the quantum of grout.

- The inside diameter of the pressure hose and grout supply line should be capable of withstanding maximum water or grout pressure to be used. The inside diameter of packer supply pipe shall be suitable for the diameter of the hole drilled.

- Arrangement for measuring the upheaval of rock/ overburden with necessary dial gauges as per IS 6066.

5.4 GROUTING MATERIAL

5.4.1 GENERAL

Grout composition shall be mixture of cement and water with possible addition of mineral fillers and fluidifiers, and or other admixtures. The grout mixes will be varied to meet the characteristics of each hole as determined by conditions encountered.

5.4.2 SAND

The sand shall consist of hard dense, durable uncoated rock fragments or natural sand with less than 3% of any deleterious substances and fineness will be such that 100% shall pass a standard IS sieve of 1.18 mm size and 50% shall pass IS sieve of 300 micron size.

5.4.3 LOCATION OF GROUT HOLES

The grout holes shall be laid out in lines, as indicated on approved drawings with secondary holes staggered with reference to the primary holes on the adjacent lines. Spacing between holes initially shall be 5 m centre to centre or as specified in the drawing. After completing the grouting through these primary holes intermediate holes will be taken in between primary holes. The number of holes for further grouting (tertiary grouting - which will be determined based on results of drilling and grouting of intermediate holes) will be such that a continuous consolidated area of satisfactory water tightness is achieved.

5.4.3.1 DEFINITIONS

- A "zone" is a series of adjacent rock strata within a predetermined depth or grout curtain.
- A "Section" is a horizontal reach along the grout curtain.
- A "Stage" is a partial or complete depth of hole for drilling and grouting purposes within any zone.
- The "Closure Method" is the procedure of locating an additional grout hole midway between two previously drilled and grouted holes.
- "Packer" grouting consists of drilling a hole to full depth and grouting from bottom of the hole upward at different depths, settings of stages by means of a packer set at required depths.
- "Stage grouting" consists of drilling a hole to a limited depth within a zone, grouting at this depth cleaning the hole and letting the grout set, re-drilling the hole to another limited depth and grouting and thus continuing in as many stages of drilling and grouting as may be necessary to secure a satisfactory job of grouting within any zone.

5.5 CASING AND DRILLING

Each hole drilled shall be protected from caving and/or being clogged or obstructed. The hole drilled in the overburden shall have a casing keyed into the rock sufficiently to exclude collapse of overburden and the joints to be water tight. The Contractor may adopt mud drilling in overburden to facilitate fixing of casing pipe in rock. This casing shall be capped and furnished with fittings for water testing or grouting. Any hole clogged or obstructed shall be cleaned out in a satisfactory manner. All metal pipes and fittings required for casing and grouting holes shall be furnished, handled, installed and removed by the Contractor. No extra payment will be made for drill bits , casing pipes or any other fittings left in or could not be removed.

5.5.1 DRILLING

After drilling through overburden and installing the casing pipe, further drilling shall be continued with the percussion drilling if the rock does not produce mud slurries. The percussion drilling shall be continued up to the required depth in the hard rock. If at any instance the rock conditions dictate use of rotary drilling then drilling shall be carried out accordingly.

In case of overburden drilling equipment (similar to Atlas Copco's Standard O.D. Unit) which has rotary action combined with percussion, the same equipment shall be continued up to the required depth. The holes should be thoroughly washed immediately before grouting with alternate jets of air and water under continuous

pressure in a manner permitting free outflow by inserting a smaller pipe and introducing air and water at the bottom of the hole. The use of grease or other lubricants on the drill rods or in the drill holes will not be permitted. The holes shall be drilled vertically or at inclinations from vertical as shown in the drawing or as directed by the Engineer. Whenever the drill water is lost or large artesian flow is encountered in any hole the Drilling operation shall be stopped and the hole shall be grouted before drilling operation is resumed. Upon completion of drilling or at any stage of hole, it shall be temporarily capped or otherwise protected from entry of foreign materials until grouting operation require it to be opened. Re-drilling required because of the Contractor's failure to clean out a hole before grouting shall be performed by the Contractor at his own expenses and no additional payment shall be made on account of the same.

5.5.2 WASHING AND PRESSURE TESTING

It will be necessary that during the drilling of grout holes in rock, or after drilling is over, the holes be completely pressure tested to a pressure equivalent to 0.23 to 0.46 kg/cm^2 per meter depth. When abnormal gain or loss of drill water is observed, caving of the hole or binding of the bit occurs during drilling or falling of the bits and drill rods as through open cavity, it will be necessary to discontinue drilling and the hole pressure tested either with or without the use of packers.

It may be necessary that upon completion of any hole, to pressure test the same using (special double seal) packers set at intervals of 3 M or less starting at the bottom and going upwards in the hole. The quantity of water taken in by the hole during testing under pressure shall be carefully observed and recorded in order to enable the Engineer to assess the type of rock and decide on the grouting procedure. Immediately before the pressure grouting of each stage of any hole is taken up, it will be necessary to thoroughly wash the hole under pressure and then pressure test it. At least the nearest two holes in advance of each hole to be washed shall be completely drilled for the same stage and the adjacent holes completely washed to allow washing and flushing out of any intervening clay-filled seams, fractures or solution channels. All the washable materials shall be washed with water and air under pressure not exceeding grout pressure. The pressure testing shall be done as per Clause 10.3 of IS: 6066.

5.5.3 GROUTING - GENERAL

Grouting mixes, pressures, pumping rates and the sequence of drilling and grouting of holes will be determined in the field by the Engineer. In no case shall the deepening of any hole preparatory to grouting be commenced before a minimum period of 16 hrs has elapsed since completion of the previous stage grouting in that hole. No Second Stage grouting shall be conducted within approximately 12.5 meters radius of any hole in which a previous stage of grouting has been completed, until the grout in such previous hole has set for a period of twenty four (24) hours. The w/c ratio by volume will be varied to meet the characteristics of each hole as revealed by the grouting operation. In general, if pressure tests indicate a relatively tight hole, grouting shall be started with thin mix. If an open hole condition exists, as determined by loss of drill water or inability to build up pressure during washing, then grouting shall be started

with a thicker mix, and with the grout pump operating as nearly as possible at constant speed at all time. The water cement ratio will be decreased, if required, till the required pressure is reached.

Pressures as high as practicable but safe against rock displacement, shall be used in the grouting. Periodic application of water under pressure shall be made to avoid premature stoppage. The rate of pumping or pumping pressure shall not be increased suddenly. The grouting shall not be considered complete till the hole takes grout at the rate of less than 2 liters per minute averaged over a period of 10 min. If due to size and continuity of fractures it is found impossible to reach the required pressure after pumping a reasonable volume of grout at minimum workable w/c ratio, the speed of pumping shall be reduced. Following this reduction, if the desired result is still not achieved the grouting in the hole shall be stopped. Then the grout shall be allowed to attain initial set, the hole shall be cleaned and after the final set of the grout additional drilling and grouting shall be taken up in this hole or in adjacent area till desired resistance is built up. The arrangement of the grouting equipment shall be such as to provide a constant circulation of grout throughout the system and to permit accurate pressure control by operation of a valve on the grout return line. Pressure gauge and adequate valves are required at the pump at each hole to control, bypass and shut off, as required by the Engineer. The equipment and lines shall be prevented from chocking by the constant circulation of grout and by the periodic flushing out of the system with water. Flushing shall be done with grout intake valve closed, water valve open and pump running at full speed.

5.5.4 GROUTING WITH PACKERS

Different grouting pressures will be required for grouting different sections of most of the holes. The grouting shall be performed by attaching a rubber packer to the end of grout supply pipe, lowering the grout supply pipe into the hole to the top of the section which is required to be grouted. The packer shall be so designed that it shall be able to expand to seal the drill hole at the specified elevation and when expanded shall be capable of withstanding pressure without leakage, for a period of 5 minutes.

After fixing the packer at required elevation, the bottom portion of the hole shall be grouted at specified pressure allowing the packer to remain in place till the grouting is completed and grout pipe shall then be withdrawn to the next higher section required to be grouted at the specified pressure and thus successively grouting the hole in stages at the specified grouting pressures until the entire hole is completely grouted.

5.5.4.1 Whenever rock lifting is anticipated the pressure shall be suitably modified. It is always better to begin with a low initial pressure say 0.1 to 0.25 kg/sq.cm per meter of overburden and build up pressure gradually. It is advisable to ensure that the pressure shall not be raised until the rate of intake falls below a lower limiting value of say 5 liters/min. The limiting value of pressure for each zone and depth of stage shall be established from the result of trial grouting along with observations of upheaval by uplift. Control of pressures shall be as per clause 12.1.4 of IS:6066.

5.5.4.2 In case different grouting pressures are required for grouting different sections & the top layers are susceptible to up-heaving the grouting can be done with double packer system also, as specified in IS: 6066.

6. CONCRETE:

6.1 SCOPE

a) This specification covers all the aspects of concrete production like procurement of ingredients, storing, proportioning, mixing, placing, vibrating and curing of plain, reinforced, pre-stressed and pre-cast concrete etc. This specification broadly covers: -

i) Requirements for source-qualification, procurement, batch qualification testing and storage of concrete ingredients.

ii) Requirements for proportioning of concrete mix, batching, mixing, Transportation, sampling, testing and acceptance of concrete of specified grades.

iii) Requirements for preparation and placement of concrete including chilling, conveying, depositing, compaction, curing, finishing, inspection, testing and preparation of construction joints and repairing, if needed.

b) Wherever information shown is in contradiction to the contents of this specification, all information pertaining to plain, reinforced, pre-stressed and pre-cast concrete shown and noted on the drawings shall be considered part of this specification and shall supersede this specification.

c) During concrete mix proportioning, it may be required, in consultation with the Engineer, to include pozzolanic material (fly ash, micro silica, GGBS etc.) either individually or in combination, to meet the specified requirement of strength and durability. Special provisions with regard to allowable limits of these pozzolanic materials, effect on properties of concrete, durability requirements of concrete have been highlighted. To achieve high level of mechanization in concrete production and placement, special requirements for batching plant, concrete pumping equipment, field practices etc. have also been highlighted.

6.2 QUALIFICATIONS AND APPROVAL OF SOURCES

All materials required for the manufacture of concrete and used for curing of concrete shall be procured only from approved sources. Such approvals shall be given by the Engineer only after due evaluation of tests and test certificates and also after further sampling and testing the materials as per relevant specifications by the contractor. It is the responsibility of the contractor to carry out investigations and evaluation of sources of material for pre-qualification. The contractor shall also ensure that at least two sources of each material are pre-qualified for ensuring uninterrupted supply of material. Bulk procurement of the ingredients of the concrete shall be made only after the contractor has completed the process of pre-qualification and the Engineer has duly approved the sources/ products. The approval of the Engineer does not, however,

absolve the contractor of his responsibility for the quality and consistent supply of the materials.

6.3 STANDARDS AND SPECIFICATIONS

The provisions of the latest revisions with amendments, if any, of the following Indian Standards and other relevant codes shall form part of this specification to the extent they are relevant. Where the provisions of these Standards/Codes are in conflict with the stipulations of this specification, the specification supersedes the respective Standard or Codes.

6.3.1 BUREAU OF INDIAN STANDARDS

IS – 383	Specification for coarse and fine Aggregates from natural sources for concrete.
IS – 456	Plain and reinforced concrete – code of practice
IS – 460	Specification for Test Sieves (Part I, II & III).
IS – 516	Methods of Tests for strength of concrete.
IS – 1199	Methods of sampling and Analysis of concrete.
IS – 1343	Pre-stressed Concrete - Code of practice
IS – 1727	Methods of test for pozzolanic materials.
IS – 1791	General requirements for batch type concrete mixers
IS – 2386	Methods of Test for Aggregates for concrete. (Part I to VIII)
IS – 2395 Part I & II	Painting of concrete, masonry and plaster surfaces - Code of practice.
IS – 2430	Methods of sampling of aggregates for concrete.
IS – 2505	Concrete vibrators – immersion type. - General requirements
IS – 2506	General requirements for concrete vibrators, screed board type.
IS – 2514	Specification for Concrete vibrating Tables.
IS – 2645	Integral Waterproofing Compounds for Cement Mortar and Concrete – Specification.
IS – 2722	Specification for portable swing weigh batchers for concrete. (Single & Double bucket type).
IS –3025	Methods of sampling and test (Physical and Chemical) for water and waste water (Part 1 to63)
IS – 3085	Method of test for permeability of cement mortar & concrete.
IS – 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS-3812 (Part-I)	Pulverized Fuel Ash – Specification: For use as Pozzolana in Cement, Cement Mortar and Concrete.
IS – 4031	Methods of physical tests for hydraulic cement (Part 1 to 15).

IS – 4032	Method of chemical analysis of hydraulic cement.
IS – 4082	Stacking and storage of construction materials and components at Site - Recommendations.

IS – 4634	Batch type concrete mixers - method of test performance of.
IS – 4845	Definitions and terminology relating to hydraulic cement.
IS – 4925	Concrete batching and mixing plant: specification
IS – 5816	Splitting Tensile Strength of Concrete – Method of Test.
IS – 5892	Concrete transit mixers - specification
IS – 6461	Glossary of terms relating to cement concrete (Part-1 to 12)
IS – 7320	Specification for Concrete slump test apparatus.
IS – 7325	Specification for Apparatus for determining constituents of fresh concrete.
IS – 7861	Code of practice for Extreme weather concreting (Part 1 & Part 2).
IS – 8112	Specification for 43-grade ordinary Portland cement.
IS – 8142	Method of test for determining setting time of concrete by penetration resistance.
IS - 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS – 9103	Concrete Admixtures – Specification
IS – 10262	Concrete mix proportioning - Guidelines.
IS – 12089	Specification for granulated slag for manufacture of Portland slag cement.
IS – 12269	Ordinary Portland cement 53-grade - Specification.
IS – 12600	Portland cement low heat - Specification.
IS – 14687	Falsework for concrete structures – guidelines.
IS –14959 (Part-I)	Determination of Water Soluble and Acid Soluble Chlorides in Mortar and Concrete (Fresh mortar and concrete).
IS- 15388	Silica fume- Specification
SP-23	Handbook on Concrete Mixes.

6.3.2 ASTM STANDARDS

ASTM C-33	Standard Specification for Concrete Aggregates.
ASTM C-94	Standard Specification for Ready Mixed Concrete
ASTM C-295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C-494	Standard Specification for chemical admixtures for concrete.
ASTM C–1202	Standard Test method for electrical indication of concrete's ability to resist chloride ion penetration.
ASTM C-1240	Standard Specification for silica fume used in cementitious mixtures.
ASTM C–1260	Standard test method for Potential Alkali Reactivity of

	Aggregates (Mortar - Bar Method)
ASTM D–75	Standard practice for Sampling Aggregates
ASTM D–1411	Standard Test methods for Water - Soluble chlorides present as admixtures in graded aggregate road mixes.

6.3.3 ACI / ASME CODES AND SPECIFICATIONS

ACI 211.1	Standard Practice for selecting proportions for normal, Heavy Weight and mass concrete.
ACI 304.1R.	Guide for the use of Preplaced Aggregate Concrete for Structural and Mass concrete Applications.
ACI 304.2R	Placing Concrete by Pumping Methods.
ACI 318	Building code requirements for structural concrete and commentary.
ACI 349	Code requirements for Nuclear safety - related concrete structures
ASME Sec-III Division-2	Code for Concrete Containments

6.3.4 OTHER STANDARDS

a) Railway Specifications – Tests for chloride and sulphate content of aggregates.

b) The European guidelines for Self-Compacting Concrete – Specification, Production and Use (EFNARC Publication).

c) DIN-1048 Specification for water permeability of concrete.

d) Concrete library of JSCE No. 36 – Recommendations for construction of concrete containing ash as a mineral admixture

e) JSCE Concrete engineering series 31- Recommendation for self-compacting concrete

f) BS6699- Specifications for Ground Granulated Blast Furnace Slag for use with Portland cement

6.4 STORAGE OF MATERIALS

a) The contractor shall make necessary arrangements, for safe storage and ensure prevention against deterioration of the materials. Cement, fly ash, GGBS, micro silica, super plasticizers, admixtures, retarders etc. shall, invariably, be stored in weather proof sheds of adequate capacity for storage of the material for at least 3 weeks' of work. However, the contractor shall ensure that sufficient quantities of all materials are available for uninterrupted progress of the work. Cement and other construction materials shall be stored as per recommendations of Indian Standards and as per manufacturer's recommendation. Storage silos shall be watertight. In the storage area, proper access and lighting shall be provided for inspection, identification and drawl of

material. The material shall be stored batch wise with proper identification tag, indicating the quantity received, batch number and the date of receipt and issue. The consignments shall be used in the order of receipt at site, unless otherwise directed. In case of large concrete pours, the material to be used shall be identified and procured well in advance, taking the quantity required for a particular concrete pour into consideration. The cement shall be used within three months from the date of manufacture. However, in exceptional circumstances, if approved by the Engineer, the above stipulation may be relaxed subject to the condition that the material shall be retested to ensure the conformity with the technical specifications. Normally, materials of different type or grade shall not be stored in the same godown. If materials of different type or different grade are stored in the same place, it shall be clearly demarcated and separated to avoid intermixing.

b) The contractor shall prepare an elaborate procedure for the periodic inspection and testing of the materials to detect any deterioration and also for segregation of the deteriorated material. The above procedure shall be approved by the Engineer and implemented by the contractor. It is the responsibility of the contractor to provide all samples and other facilities to the Engineer for carrying out inspection and testing of materials both at the source and at the site of work at his own cost. The rejected materials shall be removed from the site within 48 hours. If the contractor fails to remove the rejected material within 48 hours, the right to get the materials removed from the site rests with the Engineer and all the expenditure incurred by the Engineer for such removal shall be borne by the Contractor.

c) Coarse and fine aggregate (both normal and heavy) shall be stacked on concrete/masonry platforms separately in a manner to prevent their intermixing and to avoid contamination by foreign materials. Each size of aggregate shall be kept separately with wooden, steel, concrete or masonry bulkheads in such a way, to prevent intermixing. If necessary, rock ladders, reclamation tunnels etc. may be provided so that the grading of the material is not affected.

d) All storage arrangements, handling schemes shall be subject to the approval of the Engineer. If the storage arrangement is not to the satisfaction of the Engineer, he may direct the contractor to make such arrangements as he considers necessary and in the event of non-compliance, the Engineer reserves the right to make such arrangements as may be needed at the contractor’s risk and cost.

e) A detailed record of receipt and issue of all materials with the associated test certificates shall be maintained by the contractor and shall at all times be available to the Engineer for his scrutiny.

6.5 CONCRETE INGREDIENTS

6.5.1 CEMENT

6.5.1.1 SOURCE QUALIFICATION

a) In no case, cement shall be purchased from agents/ distributors. A minimum of two cement plants shall be pre-qualified well before the start of the concreting works.

b) In general, Ordinary Portland cement (OPC) of 43 grade conforming to IS 8112 and 53 grade conforming to IS 12269 shall be used. In addition to the requirements specified in these standards, following additional requirements shall also be met with:

i) Chloride content shall not be more than 0.05% by mass of cement.
ii) C_3A content shall be between 5% and 8%.
iii) In case of alkali reactive aggregate, alkali content, as Na_2O equivalent shall not be more than 0.6% by mass of cement.

c) Any other special type of cements i.e. Portland Pozzolana Cement (IS 1489 – Part 1 and 2), Portland Slag Cement (IS 455), Sulphate Resisting Cement (IS 12330), Low Heat Portland Cement (IS 12600), Rapid Hardening Portland Cement (IS 8041) may be used in works only with the written permission of the Engineer and only if the design of structures demands the usage of the same.

6.5.1.2 PRE-DISPATCH TESTS

All the consignments of cement shall be accompanied by the manufacturer's test certificate for individual batches, ensuring that cement meets all the requirements of the specification.

6.5.1.3 TEST AT SITE (BATCH QUALIFICATION)

a) In addition to the manufacturer's test certificate, the Contractor shall arrange for testing of the cement either at site laboratory or at any other outside laboratory approved by the Engineer. Cement samples, for such tests, shall be drawn, in the presence of the Engineer or his authorized representative. A composite sample shall be collected representing 250 MT (or such smaller quantity as may be decided by the Engineer) of cement from each grade / brand with proper batch identification. At least 10 grab samples shall be taken representing the entire batch. When cement is supplied in bowser / bulker and directly fed to the silo, grab sample shall be taken from each bowser / bulker. Composite sample shall be prepared by thorough mixing of the grab samples to represent the entire batch.

b) The tests and their frequency shall be as given in Table 6.1.

TABLE 6.1

FREQUENCY OF TESTING OF CEMENT

Sl. .No	Description of Test	Frequency
1	Normal consistency	250 MT or lesser
2	Compressive strength 3 days, 7 days, 28 days	250 MT
3	Initial and final setting time	250 MT
4	Specific gravity	2000 MT
5	Soundness	
a	Le Chatelier's method	2000 MT
b	Auto clave method	2000 MT
6	Specific surface	2000 MT

c) All the chemical tests specified in the relevant standards shall be conducted at an independent laboratory for every 20000 MT of cement supplied or at every 6 months whichever is earlier for each brand/grade. All the chemical compounds shall be reported separately. Bogue's compounds shall also be calculated and furnished.

d) The Engineer shall be able to witness sampling, testing and inspection of cement at the site laboratory or at independent laboratory. Cement shall be released for use, only after ensuring that it meets the requirements of initial and final setting time as well as 3 days compressive strength results. If required, necessary co-relation shall be established between accelerated 1-day strength with 3, 7 and 28-day strengths. Based on this co-relation, cement may be inducted into the work with the prior approval of Engineer in exceptional cases only.

e) Cost of above testing shall be borne by the Contractor. Contractor shall ensure that the construction schedule is not affected because of testing of material at outside laboratory.

f) Test results either from the site laboratory or from an approved outside laboratory shall be taken as final for acceptance or rejection criteria.

6.5.2 FLY ASH

a) Fly Ash conforming to IS 3812 (Part 1) shall only be used. Bottom ash, Ash from Air pre-heater and pond ash shall not be used for mortar as well as for concrete production. Fly ash shall be collected in dry condition from the source with proper moisture proof packing arrangement. Fly ash can also be supplied in bulk containers. For source qualification, three samples from a particular source shall be collected and tested for physical and chemical properties. If all the three samples pass the requirements given in IS 3812 (Part-1) then the source shall be considered as acceptable. However, loss on ignition shall not be more than 2% and particles retained on 45-micron sieve shall not exceed 20%. This requirement is in variance with IS 3812 (Part-1). Bidder will have

to meet the requirements given in the specification. In case the quality of fly ash collected from the source does not meet the requirements the contractor will have to use the processed flyash or install a classifier at his own cost.

b) All the physical and chemical tests specified in IS 3812 (Part-1) shall be conducted at every 2,000 MT of fly ash or at every 1-month intervals whichever is earlier. However for fineness only percentage retention on 45-micron sieve shall be the criteria for acceptance or rejection. The discretion to change this frequency rests with the Engineer depending upon the consistent performance of the previous batches. The fly ash, if stored for more than 3 months, it shall be re-qualified before its use.

c) The contractor shall get the test certificate for each batch of supply from the fly ash supplier. The contractor at his own cost shall undertake the following tests either at field laboratory or at outside approved laboratory for each batch of 100 T or part thereof:

i) Percentage retained on 45 micron sieve
ii) Loss on ignition
iii) Moisture content

6.5.3 MICRO SILICA

a) Though micro silica is available in three forms i.e. un-densified, densified and slurry form, only densified form of silica fume shall be used and shall conform to the requirements of IS: 15388.

b) Test requirements of micro silica for source qualification as well as batch qualification shall be as per Table 6.2. For batch qualification tests specified under serial No. 2, 3,5 and 6 of following table (Table 6.2) shall be conducted for every 100 Tons and all other tests shall be carried out at every 2000 Tons.

TABLE 6.2

TEST REQUIREMENTS OF MICRO SILICA

Sl. No.	Description of test	Test method	Requirements
1	SiO_2,(%), min	IS 1727	85.0
2	Maximum Moisture content (%)	See Note 1	3.0
3	Loss on ignition (%), max	IS 1727	4.0
4	Alkalies as Na_2O (%), max	See Note 2 and 3	1.5
5	Oversize percent retained on 45 micron IS sieve (%), Max	IS 1727	10.0
6	Compressive strength at 7 days as percent of control samples	IS 1727 See Note 3	85.0

7	Specific surface (m^2/g), min	IS 15388 Annexure A	15.0
8	Specific gravity*	IS 1727	-

NOTE:

1. For determination of moisture content, dry a weighed sample as received in an oven at 105^0C to 110^0C. Express the percentage loss in mass and record as moisture content.

2. For determination of alkalis, method of test used for determination of alkali in cement may be adopted.

3. In the test method for determination of compressive strength of silica fume cement mortar in accordance with IS: 1727, the value of factor N may be taken as 1.

4. Specific surface test is optional.

5. Tests specified above shall be carried out by the contractor at his own cost.

(*) For batch qualification the specific gravity value shall not deviate by ±0.2 from the values obtained during mix qualification

6.5.4 GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

a) The GGBS shall conform to BS 6699. The GGBS may be used with OPC (Ordinary Portland Cement) 43 grade conforming to IS: 8112 or 53 grade conforming to IS: 12269.

b) Test requirements of GGBS for source qualification as well as batch qualification shall be as per Table 6.3. Cost of testing shall be borne by the Contractor.

TABLE 6.3

TEST REQUIREMENTS OF GGBS AS PER BS 6699

Sl. No	Description of test	Test method	Requirements
1	Fineness (M^2/Kg)	EN-196-6	275 (minimum)
2	Soundness (Le Chatelier Expansion) in mm	EN-196-3	10.0 (maximum)
3	Loss on ignition (%), max	EN-196-2	3.0 %
4	Insoluble Residue (%)	EN-196-2	1.5 (max)
5	Initial Setting Time (IST)	EN-196-3	Not less than IST of OPC
6	Magnesia content (%)	EN-196-2	14.00 (max)
7	Sulphide Sulphur (%)	EN-196-2	2.00 (max)
8	Sulphite Content (%)	EN-196-2	2.50 (max)

Sl. No	Description of test	Test method	Requirements
9	Magnese Content (%)	EN-196-2	2.00 (max)
10	Chloride Content (%)	EN-196-21	0.10 (max)
11	Moisture Content (%)	BS 6699-APPN-E	1.00 (max)
12	Glass Content (%)	BS 6699-APPN-D	85 (min)
13	Compressive strength in (N/mm^2) After 7 days After 28 days	EN-196-1	 12.0 (min) 32.5 (min)
14 a b c	Chemical Moduli $CaO + MgO + SiO_2$ $CaO + MgO / SiO_2$ CaO / SiO_2	EN-196-2	66.66(Min) > 1.0 < 1.4

In case of use of Portland Slag Cement the cement shall meet all the requirements given in IS 455.

c) All the physical and chemical tests shall be conducted at every 500 MT of GGBS or at every 6 months intervals whichever is earlier. The discretion to change this frequency rests with the Engineer depending upon the consistent performance of the previous batches. The contractor shall also get the test certificate for each batch of supply from the GGBS supplier.

6.5.5 AGGREGATE

a) The samples of coarse and fine aggregate shall be tested by the contractor at his own cost as per Table-6.4 while qualifying the source and thereafter at regular intervals as mentioned therein. The regular supply of coarse and fine aggregates shall commence only after approval of the source. The layout of the crushing, washing and batching plant shall be subject to the approval of the Engineer. The crushing plant shall include vertical shaft impactor in the system, so as to obtain cubical aggregate as well as crushed fine material for use as manufactured sand. ***Contractor shall note that crushing of aggregate at GHAVP site is prohibited.*** Direct purchasing of crushed aggregate from outside suppliers may be allowed subject to the condition that the material so procured meets this specification. The contractor, however, is advised to procure the boulder and crush the same at a place convenient to him. Alternatively, he may establish crushing machinery at the quarry and transport the crushed aggregates/ crushed sand. All efforts should be made by the contractor to contain the dust level to the minimum so as to meet environmental standards by incorporating suitable filters and/ or any such arrangements.

TABLE 6.4

AGGREGATE TESTING SCHEDULE AND REQUIREMENTS

Sl. No.	Activity/Test	Frequency	Applicable Code	Requirement
1(*)	Petrographic strained quartz analysis by weight	One sample for new source or change in source of aggregates	IS: 383 / ASTM C-295	<20%
2(*)	Alkali reactivity			
a)	Mortar bar method	One sample fornew source or change in source of aggregates.	ASTM C-1260	Expansion shall be less than 0.10% at 16days
b)	Chemical method	One sample for new source or change in source of aggregate and Subsequently once in 6 months during progress of work.	IS: 2386 / IS: 383	Shall fall in innocuous zone
3	Chloride content	-do-	IS 14959(P-I) / Railway Spec	0.04% by wt. max.
4	Sulphate content	-do-	IS 3025(P-24) /Railway Spec.	0.40% by wt. max.
5	Iron content for heavy density aggregates	One sample for every 5000 MT for new source or change in source	NPC Spec.	Shall not be less than 60% 4.65 (for HA)
6	Specific gravity (SSD condition)	-do-	IS: 2386	2.6 (for C.A.) 2.55(for F.A.)
7	Deleterious material	-do-	IS: 2386 / IS: 383	Refer Table No.6 and 8
8	Size and Gradation	One sample for every 1000 Cum of concrete (minimum one sample per week)	IS: 2386 / IS: 383	Refer Table No. 5 and 7
9	Absorption/. Moisture content	One sample daily	IS: 2386	3% max.
109	Silt content (for natural sand only)	Once in a week	IS: 383	8% max. By volume
10	Organic impurity (for natural sand only)	Once in six months	IS: 2386 / IS: 383	No impurity
11	Flakiness and	Once in a month	IS: 2386	Individual-15%

Sl. No.	Activity/Test	Frequency	Applicable Code	Requirement
	elongation index (for C.A. only)			max.
12	Crushing value (for C.A. only)	Once in six months	IS: 2386	45%** max.
13.	Abrasion value (for C.A. only)	Once in six months	IS: 2386	
14.	Impact valve (for C.A. only)	Once in six months	IS: 2386	

(*) Based on the test results of Petrographic examination and /or alkali aggregate reaction test, if aggregate is found alkali reactive, remedial measures like restricting the alkali content of cement, admixture and/or addition of pozzolanic material shall be resorted to with the approval of the Engineer. As a normal rule, such aggregate shall not be used into work and efforts shall be made to obtain non-reactive aggregate.

(**) These limits shall be 30% (maximum) for aggregate to be used in road construction.

6.5.5.1 WASHING OF AGGREGATE

The impurity level in both coarse aggregate and fine aggregate shall be controlled. If impurities are beyond acceptable limits, the contractor shall at his own cost make necessary arrangements to wash the river sand/ aggregate before inducting the same into concrete. Silt content of sand shall be checked for each truckload and shall be brought within acceptable limits by washing. Both coarse aggregate and fine aggregate shall be washed thoroughly to remove all vegetation, perishable substances, and objectionable amounts of foreign matter, quarry dust, clay lumps, silt and such other deleterious materials. A suitable washing mechanism shall be provided as per scheme approved by the Engineer. The contractor shall prepare a detailed procedure for washing indicating the washing arrangement and get approval of the same from the Engineer. The washing arrangement shall be such as to remove the wastewater along with the unwanted materials and drain the same away from the site. It shall also not be directly let into the river/ nallah or such other existing water bodies.

6.5.5.2 FINE AGGREGATE

Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. Fine aggregate having a specific gravity of less than 2.55 (saturated surface dry condition) shall not be used. Fine aggregate shall be graded within the limits specified in Table 6.5. The sand shall be of siliceous material, sharp, hard, strong and durable and shall be free from adherent coating, clay, dust, alkali, organic material, deleterious matter, lumps, etc. Sampling of fine aggregate shall be in accordance with IS: 2430. Fine aggregate shall be so graded that concrete of required workability, density and strength could be produced using the specified water binder ratio. The method of determination of gradation shall be as per IS: 2386.

TABLE 6.5

GRADING LIMITS FOR FINE AGGREGATES

IS Sieve designation	Percentage passing by weight		
	Zone-I	Zone-II	Zone-III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-75	55-90	95-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

NOTE :

1. For crushed sand, the permissible limit on 150 micron IS sieve shall not exceed 20%. This shall not affect 5% allowance permitted on clause 1.3 of IS – 383 applying to other sieve size.

2. Fine aggregate complying with the requirement of both grading Zone-I and II of Table–1.5 are only suitable for concrete production. However, in exceptional cases, with the specific permission of Engineer the Zone –III sand may also be used.

3. In addition to above, the fine aggregate shall be so graded that the concrete of the required workability, density and strength can be produced. The method of determining gradation by sieve analysis shall be in accordance with IS: 2386.

6.5.5.2.1 FOREIGN MATERIALS LIMITATIONS IN FINE AGGREGATE

The fine aggregate shall be free from injurious amounts of dust, clay lumps, pyrites, coal, lignite, soft, elongated or flaky particles, shale, alkali, organic matter, loam, mica and other deleterious substances. The percentage of deleterious substances in the fine aggregates, as delivered to the mixer, shall not exceed the values given in Table 6.6, when tested in accordance with IS: 2386.

TABLE 6.6

LIMIT OF DELETERIOUS MATERIALS IN FINE AGGREGATE

Description of test	% By weight	
	River sand	Crushed Sand
a) Material passing 75 micron	3.0 (max)	15.0 (max)
b) Shale	1.0 (max)	Nil
c) Coal and Lignite	1.0 (max)	Nil

d) Clay lumps	1.0 (max)	1.0 (max)
e) Total of other deleterious substances such as alkali, Mica coated grains, soft and flaky particles and loam	2.0 (max)	2.0 (max)
f) Total of all above substances	5.0 (max) *	2.0 (max) *

* Excluding (a)

6.5.5.2.2 ORGANIC IMPURITIES

Aggregate, when tested in accordance with IS: 2386 (Part-2), "The method of test for aggregate for concrete – Estimation of deleterious materials and organic impurities", producing a colour darker than the standard shall be rejected. However, such sand, when tested for mortar-making properties and the mortar develops a compressive strength at 7 and 28 days of not less than 95% of that developed by a similar mortar made from another portion of same sample which has been washed in 3% solution of sodium hydroxide followed by thorough rinsing in water, then the Engineer may permit use of such sand on works.

For sand that is used after washing, the washed water from the sand shall be free from water-soluble chloride and sulphate content. The presence of chloride and sulphate content can be checked with silver nitrate and barium chloride respectively. Prior approval of the Engineer shall be taken for bringing sand from new sand quarry or change in quarry.

6.5.5.2.3 USE OF CRUSHED SAND

If the contractor desires to replace sand partially or completely, with crushed sand, he may do so only if the quality of final product meets all the requirements of these specifications. It shall be noted that crushed sand shall be manufactured by specially crushing it from the aggregate by deploying proper machinery for the same. Crusher dust obtained while producing aggregate shall not be directly used for replacing sand unless it meets the technical specifications/ grading limits specified in Table Nos.6.4, 6.5 and 6.6.

6.5.5.2.4 FREQUENCY OF TESTING AND OTHER CHARACTERISTICS

The fine aggregate shall be tested for physical, chemical & mechanical properties and impurities content as per schedule given in Table Nos. 6.4, 6.5 and 6.6.

6.5.5.2.5 COARSE AGGREGATE

Coarse aggregate for normal concrete shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, vegetation or other deleterious matter. It shall have no adherent coating. Coarse aggregate shall have an average specific gravity (saturated surface dry condition) 2.6 or more and no individual value shall be less than 2.55.

6.5.5.3.1 GRADING

The size of normal aggregate shall be selected from the standard sizes given in Table 6.7. The method of determining grading by sieve analysis shall be according to IS: 383. The stones required for making aggregates shall be transported to the crushing plant, preferably to be installed near the site of work and shall be crushed by the Contractor in primary and secondary crushers to yield the aggregates to the required sizes and specification as described under various items of schedule of quantities in Section-VIII of the document. In areas, where there is congestion of reinforcement and embedment, the Engineer may direct the contractor to use smaller size of aggregate without any additional cost for screening off the higher sizes.

TABLE 6.7

GRADING REQUIREMENTS OF COARSE AGGREGATES

Sl. No.	Nominal size	Amounts finer than each sieve (square openings)							
		50 mm	40 mm	20 mm	12.5 mm	10 mm	4.75 mm	2.36 mm	1.18 mm
1	40 to 4.75 mm	100	95 -0	30-70	-	10-35	0-5	-	-
2	20 to 4.75 mm	-	100	95-100	-	25-55	0-10	-	-
3	12.5 to 4.75 mm	-	-	100	90-100	40-85	0-10	-	-
4	10 to 2.36 mm	-	-	-	100	85-100	0-20	0-5	-
5	20 to 10 mm	-	100	85-100	-	0-20	0-5	-	-
6	40 to 20 mm	100	85-100	0-20	-	0-5	-	-	-

6.5.5.3.2 FOREIGN MATERIALS LIMITATION

The amount of deleterious substances in coarse aggregate shall not exceed the limits given in Table 6.8.

TABLE 6.8

LIMIT OF DELETERIOUS MATERIALS IN COARSE AGGREGATE

Sl. No.	**Deleterious substances**	**Maximum percent by weight of total sample**
1	Coal and Lignite	1.00
2	Shale	NIL

3	Clay Lumps	1.00
4	Soft fragments	NIL
5	Material finer than 75 micron	3.00
6	Sum of percentage of all Deleterious materials	5.00

6.5.6 WATER

a) Water used for both mixing of concrete and curing shall be clean and free from injurious amounts of oil, acids, alkalis, salt, sugar, organic materials or other substances that may be deleterious to the concrete or steel. Potable water is generally considered satisfactory for mixing and curing of concrete. The pH value of water shall generally be not less than 6. The sources of water shall have approval of the Engineer. The quality of water shall meet the provisions of IS: 3025 particularly Parts 22 and 23. The sample of water taken for testing shall represent the water proposed to be used for concreting, due attention being paid to seasonal variation. The quality of water shall be tested at every 6 months. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete or curing. The sample shall be stored in a clean container previously rinsed out with similar water. ***The exploitation of Ground Water for construction work is prohibited at GHAVP site*** .

a) Permissible limits of solids, when tested in accordance with IS: 3025 are given in Table 6.9.

TABLE 6.9

PERMISSIBLE LIMIT FOR SOLIDS

Sl. No.	**Description of test**	**Tested as per**	**Permissible limits (max.)**
1	Organic	IS3025 (Part 18)	200 mg/l
2	Inorganic	IS3025 (Part 18)	3000 mg/l
3	Sulphates (as SO_3)	IS3025 (Part 24)	400 mg/l
4	Chlorides (as Cl)	IS3025 (Part 32)	2000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work
5	Suspended matter	IS3025 (Part 17)	2000 mg/l

c) In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests of concrete.

d) Average 28-day compressive strength of at least three 15 cm size concrete cubes, prepared with water proposed to be used, shall not be less than 90 percent of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with IS: 516.

e) The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes. The initial setting time shall also not differ by more than +30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with IS: 4031 (Part 5).

6.5.6.1 USE OF ICE AND CHILLED WATER

a) The Contractor shall study the placement temperature requirement, the ambient conditions and work out the refrigeration plant capacity to meet the construction schedule. It shall be noted that the temperature of the concrete indicated in the drawings/ specifications is at the placing point. The contractor shall submit his scheme of temperature control of concrete with detailed calculations before the actual commencement of work. The temperature control may be achieved either by mixing chilled water or by addition of ice flakes depending upon the ambient conditions and transportation time.

b) Mixing water shall be kept cool by storing it under cover. Storage tank shall always be kept clean. Water shall be transported to the mixing plant in such a way that there is no rise in temperature. If chilled water or crushed ice is used as a part of mixing water to achieve the specified temperature of water, the Contractor shall install and maintain in good working condition a refrigeration plant to produce chilled water at temperature not exceeding 8ºC. The Contractor shall also build and maintain well-insulated adequate capacity storage tanks for cold water with insulated piping. To supplement this refrigeration facility, the Contractor may establish ice plant of suitable capacity. The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of start of concreting. The temperature in the cold storage shall not be higher than (-2°C).

c) Ice, if used as replacement for a portion or all of the mixing water, shall be produced from water, which meets the requirements of this specification. Ice shall be in flaky condition and such ice flakes shall have thickness less than 3 mm. The ice plant should be capable of producing flaked ice. The Contractor shall make his own arrangement for storing adequate quantity of ice. Commercial ice shall not be used. In case of large pours, where the existing refrigeration capacity is not adequate, the contractor may use commercial ice, subject to the approval of the Engineer, after ensuring that the quality standards of this specification are met with.

6.5.7 CHEMICAL ADMIXTURES

a) The Contractor shall procure all chemical admixtures required in the specification. The Contractor shall ensure consistent behavior of proposed admixtures in concrete mixes and at all ambient temperatures likely to be experienced at project site throughout the year, and especially at the recommended placement temperatures. Contractor shall

arrange for pre-qualification of such admixtures to fulfill the requirements specified in ASTM C-494 at his own cost. Qualification of chemical admixtures shall be carried out as per the guidelines given in ASTM C 494, using concrete with a cement content of 307 kg/m^3. Setting time of concrete with admixtures shall be decided by casting specimens and keeping the same in a temperature controlled room at a temperature of 23 (+/-) 2^0C. Base material of admixture shall be either sulphonated naphthalene formaldehyde based or poly carboxylic ether based only. High range water reducing and retarding admixture conforming to type G of ASTM C-494 shall be used.

b) Generically high range water reducing and retarding admixture shall be of either Sulphonated Naphthalene Formaldehyde condensate (SNF), Sulphonated Melamine Formaldehyde condensate (SMF) or Poly Carboxylate and conform to type G of ASTM C-494 depending on the fines content and limitation of chlorides, sulphates and other alkali contents.

c) The admixture to be used for Viscosity Modifying Agent (VMA) shall generically be either of Modified Cellulose or Poly-ethylene Glycol.

d) Admixture samples, when tested, shall meet the requirements given in Table 6.10.

TABLE 6.10

ADMIXTURE QUALIFICATION TEST

Sl. No	**Description of Test**	**Acceptance values for Type G**
1	Water Reduction as % of Control Mix	18 % minimum (*)
2	Air entrainment	± 1 % of control mix
3	Initial Setting Time Deviation from control At least Not more than	 1:00 hour later 3:30 hours later
4	Final Setting Time Deviation from control At least Not more than	 -- 3:30 hours later
5	Compressive strength As % of Control Mix 1 day 3 day 7 day 28 day	 125 % min 125 % min 115 % min 110 % min
6	Flexural Strength as % of Control Mix 3 day 7 day 28 day	 110 % min 100 % min 100 % min

Sl. No	Description of Test	Acceptance values for Type G
7	Specific gravity at 25^0C	Within ±0.02 of the value stated by manufacturer
8	Solid content	With ± 3% of the value stated by the manufacturer
9	Ph	7-8
10	Chloride content	0.2 % max
11	Infrared Spectrograph	Identification of base material of the admixture

(*) This value is at variance with the ASTM C 494.

6.5.7.1 SAMPLING

a) The manufacturer's tests certificates shall accompany all individual batches of admixtures. Batches of admixture, not accompanied with correlating test certificates, shall not be inducted into the work till the tests are completed and the material found meeting the standards. The batches/lots of admixture, accepted for testing, shall be identified with the unique sample number. Location of the product containers shall be distinctly identified and cordoned off to prevent mix-up with other products and brands and unacceptable materials.

b) Admixture shall be thoroughly agitated by using mechanical agitator, prior to sampling and a composite sample shall be collected representing 25.0 MT of admixture with proper batch identification. Grab sample shall be taken from each batch. Even if number of batches are less than 4, minimum 4 such grab samples shall be taken representing 25 MT of admixture and composite sample shall be prepared by thoroughly mixing the grab samples. Volume of each grab sample and composite sample shall be as decided by the Engineer.

c) It may also be noted that the admixture shall be thoroughly stirred before actual use. Mechanical stirring is mandatory and manual stirring shall not be permitted.

6.5.7.2 BATCH QUALIFICATION

Each batch of 25 MT (or lesser) of admixture shall be tested and qualified before use. All the tests, as given in Table-6.10, except 1-day compressive strength and flexural strength, shall be conducted. Admixture shall be released only after meeting the specified requirements. Infrared spectrograph of each batch shall be compared with the signature infrared spectrograph of that brand taken at the time of brand qualification to ensure consistent quality. In the event of tests failing to meet the specified requirements during batch qualification, the particular batch shall be rejected and removed from site.

Once accepted by the Engineer, one representative sample of 5 litres (approx.) shall be preserved from each batch upto 1 month from its expiry date. Such representative samples shall be identified, tagged and sealed indicating the sample identification

number, brand name, batch number, date of manufacture, date of collection and expiry date.

6.5.7.3 STORAGE

The admixture shall be accompanied by manufacturer's certificate indicating the expiry date. The product shall not be used after this date. Admixture shall be used as per manufacturer's instruction and with the control specified by the Engineer.

Utilization and storage conditions shall conform to in the corresponding technical documentation given by the manufacturer.

Contractor shall make adequate arrangement for procurement of admixture at least 45 days prior to use, as testing time for batch qualification takes minimum 30 days. Adequate quantity of tested material shall be stored to meet the construction schedule.

6.5.7.4 OTHER TYPE OF ADMIXTURES

The Engineer may, at his discretion, instruct the contractor to use any other type of admixture in concrete i.e. admixture conforming to ASTM C-494 Type A to F, water proofing admixture conforming to IS 2645 etc. These admixtures, if used, shall be qualified, on the same lines before use.

6.5.7.5 VISCOSITY MODIFYING AGENT (VMA)

a) Viscosity modifying agent shall be used in self-compacting concrete (SCC) to increase the segregation resistance of concrete. VMA shall be added in SCC as per the recommendations of the manufacture and it shall be ensured through trials that it does not have any adverse effect on any of the properties of green and hardened concrete.

b) The VMA shall generically be of water-soluble polymers, Modified Cellulose or Poly-ethylene Glycol, which are adsorbed on to the surface of the cement granules causing changes in the viscosity and the rheological properties of the mix. It shall be chloride free and compatible with all cements envisaged by IS standards.

c) Sulphonated Naphthalene based superplasticizer SNF is avoided, as it is not compatible with VMA. Other type of VMA can also be used if it meets the desired parameters of SCC, and compatible with the superpasticizer. It may be noted that there is no specific testing for qualification of VMA, other than its meeting desired properties of SCC for each batch of material (VMA).

d) Super plasticizers containing VMA may also be used for the production of self-compacting concrete subject to meeting all the desired properties of SCC.

6.6 CONCRETE MIXING PLANT

A numbers of modern concrete batching and mixing plant capable of producing concrete of specified quality and at the required output rate shall be established by the

Contractor at site. For mixing fly ash at site, Pan type mixer is preferred. A balanced complement of mixing, transporting, handling and placing equipment shall be deployed. Prior to use, the concrete mixing plants shall be completely installed and operated for a sufficient length of time to enable the Engineer to make the necessary physical tests (to assess the performance). Batching plants shall be fully automatic with computerized control along with the facility of automatic moisture correction.

Contractor shall provide, along with the tender proposal, full details of the batching plants to be deployed at site. After the award of the work, the layout of the plants, the full technical data and other details shall be submitted to the Engineer well before the actual setting of the plant.

6.6.1 TYPE OF PLANT

a) The type of plant to be deployed shall be automatic. The term 'automatic' is used to define a plant in which:

i) Batch weights are set on a mix selector manually,

ii) Mixes are batched in weigh hopper by operation of electric switch in one operation automatically,

iii) Ingredients are charged in the mixer, concrete is mixed and unloaded in a hopper in one operation by selecting mix number and operating a push button or through operation by computer.

b) Batching plant shall be capable of producing concrete according to the proportion set and controlled by the computer within the desired accuracy and tolerances specified for each of the ingredients, with different combinations of mixing sequences to produce concrete of different grades with the help of a single command. Plant software shall be capable of giving the batch weight records for each batch along with mixing cycle time in a format approved by the Engineer.

c) Each batching and mixing plant shall preferably comprise offour or five overhead storage bins for coarse and fine aggregate and cylindrical silos for cement, fly ash, GGBS and / or micro silica of adequate capacity, arrangement of adding water and admixture, to meet uninterrupted supply of concrete for placement in different pours. If cement is brought to the site in browsers / bulkers and directly loaded to the silos, then it is preferable to have minimum 3 silos for each batching plant for storage of cement. Alternatively, the silos can be kept connected to all the batching plants by providing interchangeable facility. Separate silos of adequate capacities are to be provided for fly ash, GGBS and micro silica, as the case may be, with suitable arrangement for direct loading and charging into the mixer. For loading fly ash, GGBS and micro silica, pneumatic conveyer shall be used, as screw type conveyers get choked frequently.

d) Storage bin of sufficient capacity for ice flakes shall be installed and fixed in such a way that water from melting ice shall not flow in the mixer through batcher but shall be collected in a conical vessel and drained outside.

e) The least count of weighing dials for 1 cu.m batch size plant shall be as per Table 6.11

TABLE 6.11

CAPACITY AND LEAST COUNT OF WEIGHING MECHANISM

Si.No.	Item	Capacity of dial (Kg.)	Least Count (Kg.)
1.	Cement	600	1
2.	Fly ash	600	1
3.	GGBS	600	1
4.	Microsilica	100	0.2
5.	Aggregate	2500	5
6.	Water	250	1
7.	Ice	250	1
8.	Admixture	25	0.1

f) If the batch size is different from 1 cu.m, then the capacity and least count of dials shall be modified accordingly. However, considering the demand rate of concrete, batching plant mixer of 2 cu.m. Capacity is preferred for all major concrete works.

g) Control room of the batching plant housing the instrumentation shall be free from vibrations and dust and shall be arranged as per the specification of the manufacturer. Indicators shall be fixed in such a way that operator is able to see batching of aggregate, mixing of concrete etc. directly and also all the dial indicators are clearly visible from one point.

h) All operations from charging the mixer to unloading of mix shall be interlocked so that unless mixer is empty, no new batch of ingredients is charged into the mixer.

6.6.2 WEIGHING AND BATCHING

6.6.2.1 WEIGHING UNITS

Every delivery point of aggregate, cement, fly ash, GGBS and/or micro silica into the mixer charging hopper shall have a weighing unit and each weighing unit shall include a visible, spring-less direct reading dial which shall indicate the scale load at all stages of the weighing operation from zero to full capacity. As far as practicable, the scale dials and the weighing equipment shall be in full view of the operator, so that he may conveniently observe the operation of the batcher gates and the discharge of the materials. Provision shall be made for adjustment and change in weights of materials being charged into the hopper.

Bins with adequate compartments shall be provided in the batching plant for fine aggregate and for each required size of coarse aggregate. Each bin compartment shall

be designed and operated so as to discharge efficiently and freely into the weighing hopper with minimum segregation. Means of control shall be provided such that, when quantity desired in the weighing hopper is approached, the gate shall shut off with precision. Weighing hoppers shall be so constructed that it will eliminate accumulations of tare materials and material is discharged fully.

6.6.2.2 MEASURING WATER AND ICE

Water and Ice shall be measured by weight. The mechanism for measuring and delivering water to the mixers shall not permit leakage when the valves are closed. The filling and discharge valves for the water tank shall be so interlocked that the discharge valves cannot be opened before the filling valve is fully closed.

6.6.2.3 MOISTURE CORRECTION

The batching plant shall be provided with at least one moisture probe attached to the fine aggregate bin. This probe shall sense the moisture in the fine aggregate at the time of batching and send the appropriate signal to the computer of batching plant so that adjustment in water quantity and fine aggregate quantity is made.

6.6.2.4 DISPENSER FOR ADMIXTURE

The concrete plant shall include dispensing device to accurately measure and deposit the full quantity of admixture into each mix at one time. The dispenser shall be interlocked with the batching and discharging controls of the water so that the batching and discharge of the admixtures will be automatic. The device shall be capable of ready adjustment to permit varying the quantity of the admixtures to be batched. The equipment shall be kept in a clean and fully operable condition.

6.6.2.5 TOLERANCE IN BATCHING WEIGHMENT ERRORS

The accuracy of weighing devices shall be as per Table 6.12:

TABLE 6.12

ACCURACY OF WEIGHING MECHANISM

Material	Percent of accuracy
Cement / Fly ash/GGBS	± 1 (by weight)
Water/Ice	± 1 (by weight)
Aggregate	± 2 (by weight)
Admixture	± 1 (by weight)
Micro silica	± 1 (by weight)

At least once in a month, the contractor shall check that the quantities of materials leaving the scales comply with the specified quantity within the tolerances. If

discrepancies are noticed, he shall immediately make necessary required corrections and shall undertake re-calibration.

6.6.3 MIXING TIME

a) The mixing time required should be based upon the ability of mixer to produce uniform concrete throughout the entire manufacturing process and for this; the manufacturer's specifications shall be followed. However, final mixing time should be based on the result of mixer performance test (uniformity test) made at frequent intervals throughout the duration of job. The mixing time shall be measured from the time all ingredients are in the mixer. Batch time with audible indicators used in combination with interlocks, to prevent under or over mixing of the batch and premature discharge, should be provided. The mixer shall be design for starting and stopping under full load.

b) In case of concrete with micro-silica, to ensure that agglomerates of densified micro silica break fully, mixing time required would generally be 1.5 times the time required for normal concrete and the same shall be established by conducting trials. Micro silica concrete needs additional mixing time. It is preferable to charge micro silica into the mixer along with coarse and fine aggregate, premix it for 10 seconds followed by charging of remaining ingredient i.e. cement, fly ash, water, ice and admixture into the mixer and final mixing of around 30 to 60 seconds. The time and sequence of loading shall be established by conducting trials.

c) Mixer is considered to pass the uniformity test if two samples taken after discharge of approximately 15% and 85% of the load meet the requirement given in Table 6.13**.**

TABLE 6.13

MIXER PERFORMANCE REQUIREMENTS

Sl. No.	Test	Requirement, expressed as maximum permissible difference in result of tests of samples taken from two locations in the concrete batch
1	Air entrainment	1.0 %
2 a) b)	Slump Average slump is less than 100mm Average slump is more than 100mm	 25 mm 40 mm
3	Average compressive strength at 7 days for each sample, based on the average strength of all compressive test specimens	7.5 %

d) Once the batching plant passes the performance test, for further compliance only slump test will be conducted at the frequency specified in Table 6.13.

6.6.4 RECORDS AND CHARTS

a) The Contractor shall maintain accurate records of the following at the batching plant for each batch:

i) The weight of cement, fly ash, GGBS, micro silica, water and admixture.
ii) The weight of coarse aggregate for each size recorded separately.
iii) The weight of fine aggregate for each size separately.
iv) The concrete Temperature immediately after mixing.
v) Mixing time of each batch, after all the materials are loaded into the mixer.
vi) Time of delivered of the concrete is from the mixer.
vii) Ambient temperature

b) The record shall be maintained by automatic recording and printout. Computer printouts shall also indicate the preset quantity of each ingredient, actual quantity discharged and error in it. The limits specified in the Table 6.12 shall be met (as an average) at the end of loading cycle of each transit mixer.

6.6.5 MAINTENANCE

The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free from hardened concrete. Mixer blades shall be replaced when worn down more than 10 percent of their depth. Should any mixer at any time produce unsatisfactory results or mortar leakage is observed, its use shall be promptly discontinued, till it is repaired.

6.6.6 PROVISION FOR INSPECTION

The complete plant assembly shall include provisions to facilitate the inspection of all operations at all times.

6.6.7 SAMPLING FACILITIES

Suitable facilities shall be provided for readily obtaining representative samples of concrete ingredients from any of the batchers and suitable devices for obtaining representative samples of concrete for determination of properties of fresh and hardened concrete to be made by the Contractor. All necessary platforms, tools and equipment for obtaining samples shall be made available at the start of work and shall be maintained throughout contract period.

6.6.8 CONCRETE SPECIMEN

Concrete specimen shall be prepared from the mixes used in the work and tested to determine the adequacy and accuracy of control for the materials entering into the concrete mix. The Contractor shall perform preparation, storage and testing of the specimen in presence of the Engineer to his entire satisfaction.

6.6.9 TEST WEIGHTS AND CALIBRATION

The Contractor shall provide standard test weights and any other auxiliary equipment, required for checking the operating performance of each scale or other measuring device. All the weighing scales shall be calibrated every month or whenever doubts arise or before any major pour, as directed by Engineer. Batching plant shall be allowed to use for production of concrete only if it meets the specified requirements.

6.7 PRE-REQUISITIES OF CONCRETE

6.7.1 CLASSES OF CONCRETE

Unless otherwise specifically stated as Nominal Mix, all concrete, contemplated under this specification, shall be taken to mean as "**Controlled Concrete**".

6.7.2 CONTROLLED CONCRETE

Controlled concrete is a concrete where the mix proportions are determined by mix design, preliminary mix proportioning and laboratory tests. These shall be carried out at specified intervals and also whenever the Engineer has reasons to believe that there has been a change in the quality, properties, or grading etc of any of the constituents of concrete, which, in his opinion, would impair the strength and /or durability.

Each class of concrete shall be identified by designation consisting of a prefix and two numbers like N/25/40. Prefix ‘N’, ‘H’ and ‘SH’ signifies Normal concrete, Heavy concrete made with hematite aggregates and Super Heavy concrete with a combination of hematite aggregates and chilled iron shots or steel punching respectively. Next two numbers e.g. 25 and 40 would denote the Uniaxial characteristic compressive strength at 28 days in MPa (25 MPa and maximum size of coarse aggregate in mm (40 mm) respectively.

6.7.3 NORMAL CONCRETE

Class designation of concrete shall be as specified on the drawing. Maximum size of aggregate shall be 20 mm unless specified otherwise. However, when concreting has to be carried out in congested areas, maximum size of aggregate may be suitably reduced, with the approval of the Engineer.

Unless otherwise specified on drawings or called for in the schedule of Quantities, the class designation of normal concrete to be used shall, generally, be selected from Table 6.14.

TABLE 6.14

GRADES OF NORMAL CONCRETE

Class	Characteristic Compressive Strength of 15 cm cubes at 28 days in MPa	Maximum size of aggregate in mm
N/10/20	10	20
N/20/20	20	20

N/30/20	30	20
N/35/20	35	20
N/40/20	40	20
N/45/20	45	20
N/50/20	50	20
N/60/20	60	20
Normal Grout	30*	Fine Aggregate

Normal concrete shall have a net unit weight of not less than 2400 Kg/cu.m.
* The compressive strength for grout shall be on cubes having area of face 50 cm^2.

6.7.4 MIX PROPORTIONING CRITERIA

The mix proportioning, in case of OPC concrete shall be based on 28-day characteristic strength. For concrete containing fly ash, GGBS or any other mineral admixture, the concrete acceptance criteria shall be based on 56- day strength. Any other specific requirement, if any, will be as indicated on the construction drawings.

6.7.5 DURABILITY OF CONCRETE

To meet the requirement of durability, the water content as well as water to binder ratio shall be as low as practicable. In addition, there shall be adequate compaction and immediate curing as well as curing for longer period is necessary.

6.7.6 EXPOSURE CONDITIONS

Various conditions for which the concrete will be exposed during its service life are given in the Table 6.15.

TABLE – 6.15

ENVIRONMENTAL EXPOSURE CONDITIONS

Sl. No	Environment	Exposure Condition
1	Mild	Concrete surface protected against weather or aggressive conditions except those situated in coastal area.
2	Moderate	Concrete surface sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain. Concrete continuously under water. Concrete in contact or buried under non-aggressive soil / ground water. Concrete surfaces sheltered from saturated salt air in coastal area.
3	Severe	Concrete surface exposed to severe rain, alternate wetting and drying or occasional freezing whilst

		wet or severe condensation. Concrete completely immersed in seawater. Concrete exposed to coastal environment.
4	Very Severe	Concrete surface exposed to seawater spray, corrosive fumes or severe freezing conditions whist wet. Concrete in contact with or buried under aggressive subsoil / ground water.
5	Extreme	Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals

Unless otherwise specified in the drawing, **'Severe' and 'Moderate'** exposure conditions shall be considered for Coastal and inland sites of NPP respectively and mix proportioning of all types of concrete shall be carried out accordingly.

6.7.7 MINIMUM CEMENT CONTENT, MAXIMUM W/C

Unless specifically mentioned in the drawings, the values for minimum cement content and the maximum free water-cement ratio given in the Table 6.16 for different exposure conditions and for 20 mm maximum size aggregate may be used in the mix design.

TABLE 6.16

MINIMUM CEMENT CONTENT, MAXIMUM WATER-CEMENT RATIO AND MINIMUM GRADE OF CONCRETE FOR DIFFERENT EXPOSURES WITH NORMAL WEIGHT AGGREGATE OF 20MM NOMINAL MAXIMUM SIZE

Exposure	Plain Concrete			Reinforced Concrete		
	Minimum Cement Content kg/m^3	Maximum Free water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m^3	Maximum Free water-Cement Ratio	Minimum Grade of Concrete
Mild	220	0.60	-	300	0.55	M 20
Moderate	240	0.60	M 15	300	0.50	M 25
Severe	250	0.50	M 20	320	0.45	M 30
Very Severe	260	0.45	M 20	340	0.45	M 35
Extreme	280	0.40	M 25	360	0.40	M 40

Notes:

a) Cement content prescribed in this table is irrespective of grade of cement and is inclusive of mineral admixture like fly ash, micro silica, GGBS etc

b) Maximum quantity of fly ash that shall be taken into account in the concrete composition for minimum cement content computation specified above shall be 35 % of Minimum cementitious material specified in above table, which is in line with IS 1489 requirements. However, 35% is not a maximum limit on fly ash content of concrete mix proportion.

c) Maximum quantity of GGBS that shall be taken into account in the concrete composition with respect to minimum cement content requirement specified above shall be 65 % of Minimum cementitious material specified in above table, which is in line with IS 455 requirements. However, 65% is not a maximum limit on GGBS content of concrete mix proportion.

d) Minimum cement content shall be increased by 40 kg/m^3 for 10 mm maximum size of aggregate and shall be reduced by 30 kg/m^3 for 40 mm maximum aggregate size.

6.7.8 EXPOSURE TO SULPHATE ATTACK

Requirements for concrete exposed to sulphate attack shall be as per relevant provisions of IS 456. All the recommendations for the type of cement, maximum free water/cement ratio and minimum cement content, which are required at different sulphate concentrations in near-neutral ground water having pH 6 to 9, given in the Table 6.17, shall be followed.

For the very high sulphate concentrations in Class 5 conditions, some form of lining such as polyethylene or polychloroprene sheet; or surface coating based on asphalt, chlorinated rubber, epoxy, or polyurethane materials should also be used to prevent access by the sulphate solution.

The decision of Engineer shall be followed in this regard. Such liner shall be measured and paid separately.

TABLE 6.17

REQUIREMENTS FOR CONCRETE EXPOSED TO SULPHATE ATTACK

Class	Concentration of sulphates expressed as SO_3			Type of Cement	Dense fully compacted concrete made with 20mm nominal Max. Size of Aggregate complying with IS 383	
	In soil		In ground water (g/l)		Minimum cement content kg/ m^3	Maximum W/C ratio
	Total SO_3 (%)	SO_3 in 2:1 water soil extract(g/l)				
1	Traces	< 1	< 0.3	OPC, PPC or Portland Slag cement	280	0.55

	<0.2					
2	0.2 to 0.5	1 to 1.9	0.3 to 1.2	OPC, PPC or Portland Slag cement Super sulphated cement or Sulphate resisting Portland Cement	330 310	0.50 0.50
3	0.5to1	1.9 to 3.1	1.2 to 2.5	Super sulphated cement or Sulphate resisting Portland Cement PPC or Portland Slag cement	330 350	0.50 0.45
4	1 to 2	3.1 to 5	2.5 to 5	Super sulphated cement or Sulphate resisting Portland Cement	370	0.45
5	More than 2	> 5	> 5	Sulphate resisting Portland Cement or Super sulphated cement with protective coatings	400	0.40

Notes:

a) Cement content given in this table is irrespective of the grade of cement.

b) Use of Super sulphated cement is generally restricted where the prevailing temperature is above 40°C.

c) Supersulphated cement gives an acceptable life provided that the concrete is dense and prepared with a W/C ratio of 0.4 or less in mineral acids, down to pH 3.5.

d) The cement content given in above table is the minimum recommended. For SO_3 contents near the upper limit of any class, cement content above these minimums are advised.

e) For severe conditions, such as thin sections under hydrostatic pressure on one side only and sections partly immersed, consideration should be given to a further reduction of W/C ratio.

f) Portland Slag Cement conforming to IS: 455 with slag content more than 50% exhibits better sulphate resisting properties.

g) Where chloride is encountered along with sulphate in soil or ground water, ordinary Portland cement with C_3A content from 5 to 8% shall be desirable to be used in concrete, instead of sulphate resisting cement. Alternatively, Portland slag cement conforming to IS: 455 having more than 50% slag or a blend of ordinary Portland cement and slag may be used provided

sufficient information is available on performance of such blended cements in these conditions.

6.8 PROPERTIES OF CONCRETE

6.8.1 CONCRETE MIX PROPORTIONING

Concrete shall be proportioned to obtain workable mixes for intended purpose and to meet the strength and finish requirements.

Preliminary mix proportioning shall be established by conducting trials by the contractor, well in advance, so as to meet the time schedule. Mix proportion adopted shall meet the specified properties of green as well as hardened concrete.

While conducting trials, contractor shall use the ingredients that are qualified for actual work. All efforts shall be made to carry out the trials in laboratory and after the mix is finalized, final trials shall be done at batching plant for final qualification of the mix proportion.

6.8.2 TARGET MEAN STRENGTH

The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times standard deviation. The standard deviation for each grade of concrete shall be calculated separately. When sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table 6.18 may be assumed for mix proportioning in the first instance. As soon as the test results on sufficient number of samples are available, actual standard deviation shall be calculated and used in mix proportioning. However, when adequate past record for a similar grade exists the same may be used for deciding target mean strength.

TABLE 6.18

ASSUMED STANDARD DEVIATION

Grade of Concrete	Assumed Standard Deviation MPa
M 10 M 15	3.5
M 20 M 25	4.0
M 30 M 35 M 40 M 45 M 50 M 60	5.0

Note:

a) The above values correspond to the site control having proper storage of cement; weight batching of all materials; controlled addition of water; regular checking of all materials, aggregate grading and moisture content; and periodical checking of workability and strength. In case there is deviation in the control measures at site, the value of standard deviation given in the Table-6.18 shall be increased by 1 MPa.

6.8.3 MIX PROPORTIONING METHOD

Concrete mix proportioning may be done by methods given in IS 10262, SP-23, ACI 211.1, or on the basis of past experience or by any other suitable method so that the final product meets the specified requirements for green as well as hardened concrete. Efforts shall be made to keep cement content as well as unit water content as minimum as possible, with the use of suitable quality of chemical admixture.

6.8.4 POZZOLANIC MATERIAL

Fly ash, micro silica or ground granulated blast furnace slag (GGBS), individually or in combination, may be used in concrete along with OPC of 43 or 53 grade with the approval of Engineer. The upper limit for use of these pozzolanic materials is as given below:

a) Fly ash - 50% (max.) of total cementitious material for RCC and Prestressed concrete and 70%(max) for PCC
b) Micro silica - 7.5% (max.) of total cementitious material
c) GGBS - 65% (max.) of total cementitious material for RCC and Prestressed concrete and 80%(max) for PCC

However, minimum cement content requirement specified in 6.7.7 above shall be fulfilled. It has to be ensured that desired concrete characteristics are met with. In case of self-compacting concrete, fly ash quantity in excess of 50% can be used to meet the requirement of higher fines content.

6.8.5 WORKABILITY AND SLUMP

The workability measured in terms of slump shall be determined by slump tests as per IS 1199. As majority of concrete is desired to be placed using pumps, the workability of concrete shall be such that mix is pumpable. As a general guideline, slump of 125 mm at placement point is suitable for pumping of concrete. The requirement of slump for various pours, based on the placement methods and reinforcement congestion shall be decided at site with the concurrence of the Engineer.

6.8.6 UNIT WEIGHT

Normal concrete should have a net dry theoretical unit weight of 2400 kg/m^3, when tested as per IS 1199. The unit weight of concrete of any grade shall not be lower than 2375 kg/m^3.

6.8.7 AIR CONTENT

Air content of the concrete shall be tested as per IS 1199. While deciding on mix proportioning, air content for different aggregate sizes shall be as per Table 6.19

TABLE 6.19

AIR CONTENT OF CONCRETE FOR DIFFERENT MAXIMUM AGGREGATE SIZE

Maximum Aggregate Size	Max Air Content
40 mm	1%
20 mm	2%
10 mm	3%

The actual air content of concrete mix shall not exceed by more than 1% of the values given in Table 6.19.

6.8.8 SETTING TIME

Setting time of concrete shall be determined as per IS 8142. As the setting time depends on the temperature of concrete at the time of production as well as ambient conditions, it is required to check the setting time of concrete under same temperature and ambient conditions, as envisaged in the work.

Final setting time of concrete may be kept around 10 hours during summer and around 12 hours during winter. This parameter is required to be established for different ambient conditions for deciding time at which green cutting at construction joints is to be carried out.

6.8.9 BLEEDING

Bleeding of concrete shall not exceed 5% of the water content of the concrete, when tested as per IS 9103.

6.8.10 CHLORIDE CONTENT IN CONCRETE

The total acid soluble chloride in fresh concrete determined as per IS 14959 Part-1 shall not exceed 0.6 kg/m^3 and 0.4 kg/m^3 for reinforced and pre stressed concrete respectively.

6.8.11 CUBE COMPRESSIVE STRENGTH

Uniaxial Compressive cube strength shall be determined on 150 mm size cubes, as per IS 516.

6.8.12 CYLINDER COMPRESSIVE STRENGTH

Uniaxial Compressive cylinder strength shall also be determined on 150 mm diameter 300 mm long size cylinder, as per IS 516.

Uniaxial characteristic compressive cylinder strength shall not be less than 80% of characteristic compressive cube strength.

6.8.13 Deleted

6.8.14 FLEXURAL STRENGTH

Flexural strength of concrete shall be determined as per IS 516. Flexural strength shall not be less than $0.7\sqrt{f_{ck}}$ MPa where f_{ck} is the characteristic compressive cube strength of concrete in MPa.

6.8.15 MODULUS OF ELASTICITY

The modulus of elasticity of concrete shall be determined as per IS 516. The modulus of elasticity shall not be less than $5000\sqrt{f_{ck}}$ MPa, where f_{ck} is the characteristic compressive cube strength of concrete in MPa.

If the actual measured value differs by more than ± 20% from the value obtained from the above expression then it shall be reported to the Engineer.

6.8.16 PERMEABILITY

Permeability shall be determined by conducting Rapid Chloride Penetration Test (RCPT) as per ASTM C-1202. RCPT value shall not exceed 2000 Coulombs at 56 days.

6.8.17 TRIAL MIX AT LABORATORY

Based on the guidelines given above concrete mix design and proportioning shall be carried out so that it meets the requirements of strength, workability and durability.

Preliminary trials shall be carried out to optimize the quantity of cement, pozzolanic materials and other ingredients of concrete. To qualify a mix proportion, at least 4 trials shall be carried out in the laboratory using the preliminary mix design. Following tests shall be carried out on these mixes.

(a) Slump at 0 min, 30 min and 60 min.

(b) Unit weight

(c) Air content

(d) Initial and final setting time

(e) Compressive cube strength at 7, 28 and 56 *days

(f) Split tensile strength**

(g) RCPT at 56 days

* Only for concrete containing fly ash, GGBS or other pozzolana
** Only for containment structure or specified elsewhere

The concrete shall meet the specified values for all the above properties. The mean of 28 days cube compressive strength of all the four sets shall be more than or equal to fck + 4.0 MPa and individual test value shall be greater than or equal to fck, where fck is the characteristic cube strength of the concrete in MPa.

6.8.18 ACCEPTANCE TEST AT BATCHING PLANT

To ensure that laboratory proportioned concrete mix meets all the requirements when produced using the actual batching plant and other equipment, at least 4 trials shall be conducted at batching plant. It has to be ensured that all the requirements specified in above clause are met with. At least one test shall be conducted to check the yield of the concrete. In case of significant difference from the theoretical yield and the observed yield, it shall be investigated and rectification measures shall be taken.

Contractor shall submit a detailed report on the concrete mix proportioning to the Engineer for his approval. This report shall include the test results on concrete ingredients, laboratory trial results and batching plant trial results.

6.9 TESTS ON CONCRETE

Samples from fresh concrete shall be taken as per IS 1199 at the placement point or pumping point. Frequency of testing shall be as given in Table 6.20

TABLE 6.20

FREQUENCY FOR DETERMINATION OF PROPERTIES OF FRESH AND HARDENED CONCRETE

Sl. No.	Description of test	Frequency of testing
1	Slump	First 3 transit mixers and then from every 5th transit mixer
2	Temperature	First 3 transit mixers and then from every 5th transit mixer
3	Unit weight	At the time of casting of cubes one sample per day for each grade
4	Air content	One sample per week for each grade
5	Initial and final setting time	One sample per week for each grade
6	Bleeding	Whenever required
7	Cube compressive strength 7, 28 and 56* days	One sample per 50 cum up to 100 m^3 of concrete, there after one sample for each 100 m^3 or part

Sl. No.	Description of test	Frequency of testing
		thereof. At least one sample on each day of concreting for each grade.
8	RCPT	One sample per week for each grade
9	Chlorides and sulphate content test	One sample for each grade of concrete per six monthly

- Only for fly ash concrete/GGBS concrete.
- One sample for strength test means sufficient number of cubes to determine average of at least 3 cubes at specified time

6.9.1 ACCEPTANCE CRITERIA

Concrete of each grade shall be analyzed separately. The concrete shall be deemed to comply with the compressive strength requirements when both the following criteria are met with:

a) The mean strength determined from any group of four consecutive test results compiles with the value given in column (2) of Table 6.21

b) Any individual test result complies with the value given in column (3) of Table 6.21

TABLE 6.21

COMPRESSIVE STRENGTH COMPLIANCE REQUIREMENT

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in MPa	Individual Test Result in MPa
(1)	(2)	(3)
M 15	≥ (f_{ck} + 0.825 X established standard deviation (rounded off to nearest 0.5 MPa) or (f_{ck} + 3) MPa Whichever is greater	≥ f_{ck} – 3 MPa
M 20 or Above	≥ (f_{ck} + 0.825 X established standard deviation (rounded off to nearest 0.5 MPa) or (f_{ck} + 4) MPa Whichever is greater	≥ f_{ck} – 4 MPa

NOTE:

a. In the absence of established value of standard deviation, the value given in Table 6.18 may be assumed, and attempt should be made to obtain result of 30 samples as early as possible to establish the value of standard deviation.

b. Concrete is liable for rejection, if criteria mentioned in Table 6.21 is not met with.

c. If the concrete, after opening the shutter, is found to be porous or honeycombed, or concrete placing is interrupted without providing a proper construction joint or the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met with, it is liable to be rejected.

d. However, the same may be accepted if remedial measures are feasible and if the same are carried out to the satisfaction of the Engineer-in-charge.

6.9.2 USE OF 7 DAYS TEST

For any mix, a correlation between 7 day and 28 day strengths may be established in the laboratory. Soon after a job starts, a similar correlation shall be established during actual progress of the work. After the correlation has been established, the results of the 7 day test may be used as the precursor for the expected compressive strength at 28-days. If 7-day test indicates low compressive strength, corrective measures shall be taken without waiting for 28-day strength results. Similarly for concrete with fly ash, GGBS and micro silica, co-relation shall be established between 7, 28 and 56-day compressive strength.

6.9.3 FAILURE TO MEET STRENGTH REQUIREMENT

In the event of concrete, tested in accordance with the relevant standards, fails to meet the acceptance criteria specified in Table 6.21 above with the approval of Engineer, any or all of the following measures shall be taken by the contractor, with no extra cost to the owner.

1. Taking cores from the structural element, where the test has failed, (IS: 456).
2. Extended curing of the concrete represented by the specimen.
3. Load tests on part of structures as per IS: 456.
4. Non -destructive test on structure.
5. Replacement of affected part / parts of the structure.

6.9.4 NON DESTRUCTIVE TESTS

In case of doubts about the quality of concrete in the construction, non -destructive tests shall be conducted as directed by the Engineer. The tests shall be carried out by a specialized agency as per the provisions of IS 456. Based on the NDT evaluation, decision on acceptance of structure or otherwise shall be taken by the Engineer.

6.9.5 CORE TEST

Three cores shall be extracted from the structure for determination of compressive strength represented by that structural element. The diameters of core shall be at least 3 times the maximum size of aggregate used in the concrete and height to diameter ratio shall be 2.0. Core shall be tested as per IS 516. Concrete in the member, represented by a core, shall be considered acceptable, if the average equivalent cube strength of the

core (computed as 125% of the core cylinder strength) is equal to at least 85 percent of the specified characteristic strength and no individual average equivalent cube strength of core has strength less than 75% of the specified characteristic strength.

6.10 CONCRETE PRODUCTION, TRANSPORTATION & PLACEMENT

6.10.1 TEMPERATURE CONTROL

a) The concrete placement temperature shall be specified in the construction drawing. Normally, four different placement temperatures i. e. not exceeding 19^0C, 23^0C, 29^0C & 38^0C may be specified in the drawings. Generally, concrete temperature at the production point shall be maintained lower than the specified placement temperature so as to meet the criteria of specified placement temperature. Required temperature shall be achieved by reducing the temperature of water, replacement of part of mixing water with ice flakes and also by controlling the temperature of coarse and fine aggregate.

b) The stockpiles of the aggregate shall be protected from direct sunlight to avoid heating of aggregate. Wherever water is sprayed, suitable correction shall be applied so that the mix proportioning is not altered. Water shall be sprayed on the aggregate stockpile at every 300 mm or 450 mm height as the stockpiles are built up. The stockpiles, thereafter, shall be kept cool by water sprays. Fine aggregate may be stored under shed / in covered area, if the contractor so chooses.

c) If necessary, the coarse aggregate shall be taken into the bins and chilled water at temperature not more than 8^0C shall be sprayed on it through perforated pipe and allowed to be drained through screen fixed at the bottom. Draining screen shall remove excess water from the aggregate. The capacity and arrangement of the bins shall be such as to supply moisture free cooled aggregate to the top of the batching plant so that continuous supply of temperature controlled concrete is maintained.

6.10.2 TRANSPORTATION

a) The concrete shall be transported from the batching plant to the placement point as rapidly as possible by using insulated transit mixers for preventing segregation and loss of any of the ingredients. During hot weather, transit mixer shall be insulated to reduce loss of water by evaporation and heating of concrete from the ambient heat.

b) Once the concrete is mixed in the batching plant, no further water shall be added.

c) Concrete shall be placed and compacted in its final position within the forms within 90 (Ninety) minutes after the addition of water to the mixer or initial setting time of the concrete whichever is less.

d) The Concrete that has been left standing and has become stiff, such that it cannot be placed in satisfactory condition, shall be removed from the place of work immediately.

e) All equipment, used for transporting and placing of concrete shall be maintained in clean condition. All buckets, hoppers, chutes, transit mixers and other equipment shall be thoroughly cleaned periodically during placement and after completion of concreting.

6.10.3 RE-DOSING OF ADMIXTURES

a) In case, when transit mixer reaches placement point, the loss of slump is observed, re-dosing of admixture may be carried out, to get required consistency for getting pumpable mix. However, basis for re-dosing shall be established by conducting trials in advance to establish re-dosing requirement for getting required slump. The total quantum of admixture established at the trial stages shall, however, not be exceeded during re-dosing.

b) Suitable arrangements for re-dosing of admixture with dispensing unit shall be made to ensure accurate re-dosing and proper mixing.

c) Record shall be maintained for each such re-dosing and shall be incorporated in batch weight record of batching plant. Samples for determination of compressive strength and other parameters shall be taken only after re-dosing.

6.10.4 PLACING OF CONCRETE

a) The concrete shall be preferably placed to its final position in the structure using pumps and placer booms in such a manner that both quality and uniformity of concrete, in terms of W/B or W/C ratio, slump, air content and homogeneity is preserved.

b) Before any concrete is placed, the entire placing programme detailing equipment, layout, and proposed method shall be submitted to the Engineer for approval. No concrete shall be placed until the Engineer’s approval is obtained. Such plan shall include all the standby arrangements and shall be submitted at least 48 hours prior to actual concreting.

c) Sufficient plant capacity and transportation equipment shall be available to ensure continuous delivery of concrete at the desired rate of pour. The rate of delivery of concrete shall be such as to ensure proper handling, placing, vibrating and finishing of the concrete and to ensure that the cold joint is avoided. No concrete shall be transported in open, while it rains. If there is any sign of washing of cement and sand, the concrete shall be removed immediately. If the concrete is to be placed at night, sufficient illumination shall be ensured. Safe working condition shall also be ensured.

d) The method of delivering and handling of concrete shall be such as to facilitate placing with minimum of re-handling and without damage to the structure or the concrete.

e) All items to be embedded in concrete shall be correctly positioned and securely held in position, well in advance of placing of concrete. However, shutter alignment shall be checked and cleared only after fixing and correctly aligning the embedded parts.

f) Concrete shall be deposited at or near its final position in the form. The concrete shall not be pushed laterally with the help of vibrator. Struts, stays and braces serving temporarily to hold the forms in correct shape and alignment during the placing of concrete, shall be removed only when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from forms and not buried in the concrete.

g) While preparing for placing of concrete, all sawdust, wood chips and other construction debris, shall be removed from the forms. Prior to placing of concrete on a rock surface, it shall be thoroughly cleaned and soaked with water for about 24 hours and surface shall be remain moist condition.

h) Concrete shall be placed in such a way that segregation is avoided and also the displacement of the reinforcement and embedment is avoided. Open troughs and chutes shall be of metal or metal lined. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths to adjust the direction of movement. The addition of water, at any point in the system of transportation, to facilitate the movement of concrete shall not be permitted. All chutes, troughs and pipes, shall be kept clean and free from coatings of hardened concrete by thoroughly flushing them with water after each placement. Water used for flushing shall be discharged clear of the structure. Concrete shall neither be permitted to fall freely from a height of more than 1.50 m nor to strike the forms at an angle. Where drop chutes are used, a sufficient numbers must be provided so that the concrete discharged from the chutes are not required to flow laterally more than 10 m However, SCC can flow horizontally upto approx. 12 m to 15 m without segregation. Where a drop chute is swung from the vertical, the bottom two sections must be maintained in a vertical position to avoid segregation. Flushing water quality shall be same as that of the water, which is being used, for making concrete. Based on the work demand, if lift height is to be increased beyond 1.5 m proper arrangements for vibration shall be ensured. In locations, where direct placement is not possible and in narrow forms, suitable drop chutes or “elephant trunks” shall be provided to confine the concrete during placement.

i) Concrete shall not be placed into the forms, until the cleaning of concrete surfaces of previous pours and the placement of reinforcing steel and embedded parts have been inspected and cleared by the Engineer.

j) Storm water or water from curing of concrete, which may get accumulated on the surface of the bedding layer, shall be removed by suitable means before start of placement. No concrete shall be placed on a water-covered surface. However, the surface must be sufficiently soaked and shall be in saturated surface dry condition.

k) Concrete shall be placed in successive layers ranging in thickness not exceeding 500 mm or as directed by the Engineer. The bucket loads or other units of deposit shall be spread progressively along the face of the layer with such overlap as will facilitate spreading the layer of uniform depth and texture with a minimum hand shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar on to stones. If such condition arises, the cause or causes shall be investigated

and corrective action shall be planned. If required, mix proportion can be revised or method of placement can be modified.

l) When less than a complete layer is placed in one operation, it shall be terminated at a vertical bulkhead. Each layer of concrete shall be placed and compacted before initial setting of concrete of the previous layer takes place, to prevent injury to green concrete and to avoid separation between the consecutive layers.

m) During hot weather and rains, the concrete shall be covered with tarpaulins. Transportation, placement and consolidation of concrete shall be done in shortest possible time. Adequate precautions shall be taken to cover the transit mixer and chilled water may be sprayed over the transit mixer and the pipelines to maintain the temperature during the hot weather.

n) When concrete is to be placed in hot weather conditions, special provision shall be made for handling, placing and protecting the concrete, to ensure that concrete of full strength and free from damage, is obtained. For meeting the desired objective, means such as concreting during cooler hours of the day, use of chilled water, cooling of pipes etc., shall be resorted to. Commencement of concrete pour shall be avoided during heavy rains, storms and high winds.

6.10.5 COMPACTION

a) Vibrator should be inserted and withdrawn vertically at close intervals, using a systematic pattern of vibration to ensure that all concrete is adequately consolidated. As long as a vibrator needle sinks into the concrete by its own weight, it is not too late for the concrete to benefit from re-vibration, which improves compressive and bond strengths. Vibrators should not be used to move concrete laterally

b) On vertical surface, where air void holes are expected, voids can be reduced by the use of form vibrator or light tamping with wooden mallets.

c) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into corners and angles of the forms.

d) Internal vibrators shall be inserted in a vertical position only, at intervals of about 450 mm depending upon the mix, the equipment used, the type of structure and experience gained on job. The vibrator needle shall be inserted by minimum 100mm in the previously laid layer. The zone of influence of needle vibrator is approximately 100 times cross sectional area of the needle being used. The vibrators shall be withdrawn slowly, approximately at the rate of 75 mm/sec. The spacing shall provide some overlapping of the area vibrated at each insertion. In no case shall vibrators be used to move concrete laterally inside the forms. Vibrator needle shall be kept clear of forms least by 100 mm. Over-vibration as well as under vibration shall not be done.

e) The internal-immersion type vibrators shall be high frequency vibrators with speed of not less than 7000 rpm when immersed in the concrete. Vibrators shall be used in sufficient numbers and power of each unit to properly consolidate all concrete in each

layer immediately after it has been placed in the forms. It shall be ensured that sufficient numbers of vibrators are available at site along with adequate standby units.

f) While placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be taken to ensure adequate vibration, blending and melding of the concrete between the succeeding layers. The vibrator shall penetrate full in the layer being placed and also penetrate the layer below by about 50 mm while the under-layer is still plastic, to ensure good bond and homogeneity between two layers and prevent formation of cold joints.

6.10.5.1 USE OF FORM VIBRATORS

In case of the columns having congestion of reinforcement, supplemental form vibration may be used in addition to needle vibrators. Care should be taken to avoid excessive vibration, which would cause a weak paste on surface. However, this shall be preplanned activity and shutter as well as staging shall be designed for the additional loads form the vibrators.

6.10.5.2 USE OF SURFACE VIBRATORS

Surface vibrators may be used for horizontal elements like slabs. The vibrator operator shall be qualified before deploying on a job. Re-qualification shall be carried at suitable interval.

6.10.6 CONSTRUCTION JOINTS AND KEYS

When the work is to be interrupted, horizontal and vertical construction joints and bonding keys shall be located and shall conform to the details given on the drawings. In case of water retaining structure, containment structure and other structures, water stops as specified on the drawing shall be provided.

In case of columns, beams and slabs etc, the location of the joints shall be as indicated in the drawing or as directed by the Engineer. Concrete in a beam shall be placed throughout, without a horizontal joint. Before fresh concrete is placed, cement skin or any loose or porous material of partially hardened concrete shall be thoroughly removed and cut back until the solid face is exposed and surface made rough by hacking, or any other method. Rough surface shall be thoroughly wetted for about two hours and shall be in surface dry condition before new layer of concrete is placed over it.

6.10.7 TREATMENT ON SUSPENSION OF WORK

Whenever work is suspended on any section for more than two hours, the horizontal edges of the concrete next to the forms on surfaces that will be exposed shall be brought to a horizontal plane perpendicular to the plane of the forms and treated, so that the finished work will show smooth straight lines.

6.10.8 EXPANSION JOINTS AND SEPARATION JOINTS

These joints in concrete structures shall be provided, as specified in the drawing. The thickness of polythene sheet, if used, shall not be less than 500 microns. For Expansion joints relevant specification shall be followed.

6.10.9 WASH WATER

Wash water shall be removed in a manner to prevent running down and staining of concrete surfaces, exposed on completion of the job. Should unsightly wash-water streaks develop on the exposed surface, the same shall be removed to get a uniform colour and texture.

6.10.10 PLACEMENT INTERVAL

Placement interval between two subsequent or adjacent pours shall be as specified in the drawing.

6.10.11 CONSTRUCTION JOINT TREATMENT

Green cutting shall be made to treat the entire construction joint. Suitable surface retarder shall be used to retard the setting of concrete to a depth of 5 to 7 mm from the exposed surface that is going to receive subsequent concrete.

Green cutting shall be done by using air water jet at a suitable pressure to remove laitance from concrete surface at construction joint, exposing aggregate matrix, and shall be done only after the concrete is in final set condition. The water from the air water jet, used for green cutting of the concrete surface, shall be properly drained so as not to harm the quality of the concrete already placed. It shall also be ensured that this water does not get stagnated on the surface of concrete, depositing washed cement particles. As a pre-qualification, field mock-ups shall be conducted to check the adequacy of the material and method to be deployed on the job, before adopting in the field. In case of change in material source / type or methodology of green cutting, pre-qualification shall be redone. In areas where green cutting is not feasible, spraying of retarders followed by wire brushing immediately after final setting shall be adopted.
Approved brand of surface retarding (set retarding) agent shall be used for preparation of construction joint by green cutting of concrete. It shall be solvent free poly-hydroxyl compound and shall have a distinctive colour, which could be easily identifiable on its application over concrete. It shall be suitable for removing the cement-sand matrix between 5 to 7 mm depth after final setting time, when air water jet with a pressure of around 7 Kg/cm^2 from distance of approx. 500 mm is used. It may be noted that there is no specific testing for qualification of surface retarders other than its meeting desired performance specified above.

6.10.12 PLACEMENT OF CONCRETE AROUND LARGE OPENINGS

While placing concrete around large openings in walls, adequate care shall be taken to ensure proper flow and compaction of concrete on the underside of such openings. Adequate number of windows shall be provided in the formwork for air to escape and also for insertion of vibrators. Once the concrete reaches the level of such window, the same shall be properly closed before proceeding with further concreting.

6.10.13 PLACING CONCRETE BY PUMPING

a) As far as possible, concrete shall be placed using pumping. A steady supply of pump-able concrete is necessary for satisfactory pumping. Concrete pumps to be deployed on the work shall be able to deliver concrete at a desired rate up-to the placement point uninterruptedly.
b) Requisite numbers of concrete pumps, capable of pumping concrete at required rate, together with a complement of pipelines, accessories, spare parts, power controlled placer booms, experienced pump operators and maintenance staff shall be deployed.
c) The pumping plant shall be installed on each occasion, with preliminary mock operation for a sufficient length of time prior to scheduled placement of concrete, to enable conducting pump-ability tests and necessary adjustments for the mix proportioning, prior to use in actual work.

6.10.14 PUMPABILITY TRIALS

No mix shall be used in actual work until pump-ability trial is conducted. The actual field condition shall be simulated. The batching and conveying by transit mixers shall be in the same way as that will be in actual work. The pipe and hose layouts shall simulate the actual condition, as far as practicable. The system shall be able to meet uninterrupted desired supply of cohesive mix at the placement point. The samples shall be collected at batching plant, at pumping point and at placement point after pumping for slump and determination of compressive strength.

6.10.15 FIELD PRACTICES

a) Proper planning of concrete supply, pump location, line layout, placing sequence and the entire pumping operation shall be done by the Contractor, before commencement of concreting.

b) The pumps shall be as near to the placing area as practicable and proper access roads shall be available for movement of transit mixers and other equipment around the location.

c) Direct communications shall be maintained between the pump operator, concrete placing crew and the batching plant. As a final check, the pump shall be started and operated without concrete to assess that all moving parts are in operating conditions.

d) The mortar shall be pumped into the line to provide initial lubrication for the pump and pipeline. The mortar used for lubrication shall be collected in the bucket and disposed

off. This mortar shall not be placed in the forms. As soon as concrete is received, the pump shall be run slowly until the lines are completely filled and the concrete is slowly moved. Once the pumping starts, the operator shall ensure that the hopper of the pump is not emptied beyond a certain level, as air may enter the pipeline and cause choking.

e) Continuous pumping should be ensured. If delay occurs due to supply of concrete, form repairs, or any other reason, the pump shall be slowed down to maintain some movement of the concrete till normal supply is resumed. For longer delays, the concrete in the receiving hopper shall be kept moving in the line by giving one stroke of the pump at longer interval. In confined areas, attempt shall be made by the Contractor to run a return line back to the pump, so that the concrete can be re-circulated during such delays.

f) Minor blockages shall be cleared by operating a few strokes of the pump in reverse direction and then by returning to normal forward pumping. If this fails, a succession of reverse and forward strokes shall be carried out to remove the blockage. Should this fail, the blockage may be due to air lock and the entrapped air has to be removed.

g) Blockages in the pipe are usually assessed by the sound when the pipe is struck. To remove the obstruction, the concrete pipe shall be taken out at the assessed location and cleaned. The pumping process shall then be started again.

h) This method of checking the blockage and setting it right shall be done as early as possible, as excessive delay will cause setting of concrete in the pipeline downstream of the blockage. When the blockage is being found out and remedial measures taken, the pump shall periodically be given one or two strokes forward to keep the concrete in motion. If blockage occurs in the placer boom, a pipe joint near the base of the placer boom shall be opened and the boom made vertical to drain the concrete by gravity.

i) The termination of pumping operation shall be carefully planned to utilize the concrete dormant in the pipeline and the hopper, when the pump is stopped. However, concrete at placement point shall be kept green, avoiding cold joint, by operating standby pump or by any other standby arrangement.

j) When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a go-devil be inserted and forced through the line to clear it out. Water under pressure shall be used to push the go-devil. The go-devil shall be stopped about one meter from the end of the line, so that the water in the line does not spill over into the placement area. After flushing, water in the pipe shall be removed by drain cock provided for this purpose, in the lowest part of the line. After all concrete has been removed from the line, pipes and equipment shall be immediately cleaned.

6.10.16 QUALITY CONTROL

Contractor shall ensure good workmanship and also the plant shall be maintained to meet peak demand. Degree of control on all the concrete operation, right from selection

of the ingredients to the final testing of specimen, shall be in line with the approved Quality Assurance Plan.

The Contractor shall engage experienced supervision at all levels. Complete crew, engaged in each of the concreting activity, shall be duly qualified for a particular activity and shall demonstrate their skills and capabilities to produce the final product meeting specified parameters.

6.10.17 CURING OF CONCRETE

a) Exposed surface of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least 7 days (10 days for hot weather condition) from the date of placing concrete in case of OPC Concrete and at least 10 days (14 days for hot weather condition) where mineral admixture or blended cement is used. The Quality of curing water shall be the same as that used for mixing concrete. Any type of the covering that would stain or damage the concrete during or after the curing period shall not be permitted. Covering shall be kept continuously wet during the curing period.

b) The structural elements with concrete having low water binder ratio and also when cement is partially replaced by pozzolanic material, the curing shall be done in two stages viz., initial curing and final curing.

c) **Initial Curing:** The initial curing shall start immediately after finishing. The concrete surface exposed to environment shall be kept covered by plastic sheet or other type of impermeable covers. The wet curing shall start immediately after the final set. This shall be carried out with the help of placing wet burlaps over the concrete surfaces.

d) **Final curing:** The final curing shall be done with water. It shall commence immediately after initial curing and continue upto a minimum period specified above. Hessian cloth can be wrapped on to columns and on vertical surfaces and the same shall be kept wet all the time by a suitable arrangement.

e) Contractor shall make suitable arrangement for continuous water supply, along with necessary equipment for getting a nozzle pressure of not less than 7 kg/cm^2, even at the highest elevation, for convenient and effective jetting on concrete surfaces for green cutting, for cooling aggregate, for curing and for other requirements. All necessary appliances such as hose, sprinklers, spraying devices etc. may be made available.

f) For curing of concrete in pavements, sidewalks, floors, flat roof or other level surfaces, the ponding method of curing is preferred. Special attention shall be given to edges and corners of the slab to ensure proper protection. The ponded area shall be kept continuously filled with water throughout the curing period.

g) **Membrane Curing:** Curing compound may be used in lieu of moist curing with due qualification of material and process, if permitted by the Engineer. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set.

6.10.18 PROTECTING FRESH CONCRETE

Newly placed concrete shall be protected from rain, sun and wind. Concrete placed below the ground level shall be protected from falling earth during and after placing. Concrete placed in ground, containing deleterious substances, shall be kept free from contact with such ground or with water percolating from such ground during placing of concrete and for a period of at least 3 days. The ground water around newly poured concrete shall be maintained to a level lower than the fresh concrete layer by pumping or other means of drainage. Adequate steps shall be taken to prevent flooding. Fresh concrete shall be protected by, leaving the forms in place, prevention of disturbing shocks and vibrations and avoiding premature stressing until the concrete attains sufficient strength to sustain such loads or shocks.

6.11 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

A procedure shall be prepared by the contractor for carrying out inspection, repair and replacement of unsatisfactory concrete. Repair of unsatisfactory concrete shall be carried out by means of removing the unsatisfactory portion and replacing it with new concrete. Suitable keys, dovetail slots etc. may be provided to get proper bond between new concrete and old concrete. Prepared surface shall be kept wet for 24 hours immediately before the patching material is placed. However, surface shall be dry. Repair of concrete shall be carried out using skilled workmen. Repairs shall be undertaken as soon as practicable, after removal of forms, so as to meet the requirements of finish in that particular location. The portion of the concrete to be repaired may be reinforced with steel mesh, if directed by the Engineer. The contractor shall carry out all such repair with no extra cost to the owner.

The complete methodology for the repair shall have approval of the Engineer before undertaking such repair job. Proper curing shall be ensured for the repaired portion.

6.11.1 USE OF EPOXY

For bonding fresh concrete with old concrete epoxy shall be used if specifically directed by the Engineer. The type of epoxy and its application shall be as directed by the Engineer. Epoxy shall be applied in strict accordance with the instructions of the manufacturer. Approved material shall be arranged by the Contractor to undertake this activity.

The epoxy shall meet the requirements of ASTM C-881 and shall be used as per manufacturer’s recommendations.

6.11.2 REPAIR WITH EPOXY MORTAR

The defects in concrete (within the acceptable limits, as decided by the Engineer) may be repaired using Epoxy mortar as per the instructions of the Engineer. No extra payment shall be made for such repairs.

6.11.3 MATCHING OF PATCH SURFACES

Filling material used in repair of surfaces, which will be exposed after completion of the project, shall be used with cement from the same source as that used in concrete and blended with a sufficient amount of white Portland cement to produce the same colour as in the adjoining concrete. Patched surface shall be given a final treatment to make the texture of the patch to match with the surrounding area.

6.11.4 CURING OF PATCH WORK

Immediately after any patchwork is completed, the area shall be covered with non-staining, water-saturated material and the same shall be kept wet and protected against sun and wind for a period of 12 hours. Thereafter, the area shall be kept continuously wet by a fine spray or sprinkling of water. The layers of patch may be reinforced with steel wire mesh, if directed so by the Engineer at no extra cost to the owner.

6.11.5 APPROVAL BY ENGINEER

All materials, procedures and activities for repair work as well as finishing work shall be subject to the approval of the Engineer.

6.12 FINISHING & OTHER GENERAL WORKS

6.12.1 FINISHING

a) Unless otherwise specified, concrete finishes shall conform to the following classifications and shall be provided as specified in the drawing.

b) Finish F1, F2 and F3 shall describe formed surfaces.

c) Finish U1, U2 and U3 shall describe unformed surfaces.

d) Offsets or fins caused by displaced or misplaced form panels, lining or form section or by defective form lumber shall be referred to as ‘abrupt irregularities’. All other irregularities shall be referred to as ‘Gradual irregularities’. Gradual irregularities shall be measured as deviation from a plane surface with a template 1.5 m long for formed surfaces and 3.0 m long for unformed surfaces.

6.12.2 FORMED SURFACE

a) Finish F1 shall apply to all formed surfaces for which finish F2, F3 or any other special finish is not specified.

b) Finish F1 shall include filling all form tie holes and localized air holes.

c) Finish F2 shall apply to all formed surfaces as shown on the drawings. Finish F2 shall include filling all form tie and localized air holes, repair of gradual irregularities exceeding 6 mm, removal of ridges and fins and abrupt irregularities by grinding.

d) Finish F3 shall apply to all formed surfaces exposed to view or where shown on the drawings. It shall include all measures specified for finish F2. In addition, filling air holes with mortar and treatment of the entire surface with sack rubbing shall include in F3 finish. It shall also include clean up of loose and adhering debris. The surfaces shall be prepared within two days after removal of the forms. The surfaces shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and half part by volume of fine sand passing IS No. 16 sieve. Only sufficient mixing water, to give the mortar a workable consistency, shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean with burlap so that the entire surface presents a uniform appearance without air holes and irregularities. The finished surface shall be cured for a period of 3 days.

6.12.3 UNFORMED SURFACES

a) Finish U1 shall apply to all unformed surfaces for which finish U2, U3 or any other special finish is not specified. Finish U1 shall include screeding the surface of the concrete to the required slope and grade, as specified on drawings.

b) Surfaces, to be covered with concrete topping, terrazzo etc., shall be smooth, screeded and leveled to produce an even surface and irregularities not exceeding 6 mm.

c) Finish U2 shall apply to all unformed surfaces, as shown on the drawings. Finish U2 shall include screeding and applying a wood float finish to the surface of the concrete to the required slopes and grade, repair of abrupt irregularities unless a roughened texture is specified and repair of gradual irregularities exceeding 6 mm.

d) Finish U3 shall apply to unformed surfaces for which a high degree of surface smoothness is required, where shown on the drawings. Finish U3 shall include screeding, floating and applying a steel trowel finish to the surface of the concrete to the required slope and grade, repair of gradual irregularities exceeding 6 mm, finishing joints and edges of concrete with edging tools.

6.12.4 FOUNDATION BEDDING, BONDING AND JOINTING

a) All surfaces or concrete beds shall be prepared by suitable shaping, thorough cleaning, washing and keeping the surface in SSD condition

b) All soil surfaces, upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced with lean concrete or with selected soil and compacted to the same density as the surrounding area. The surface of absorptive soil, against which concrete is to be placed, shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete.

c) The concrete surfaces, upon which additional concrete is to be placed, shall be prepared by green cutting technique. Surface retarder shall be spread on the surface of newly laid concrete, just after finishing work is completed. After the concrete attains final set, high-pressure air water jet shall be used to remove cement matrix, exposing aggregate matrix. The water shall be drained properly along with cement particles. In case where green cutting is not adopted, with approval of the Engineer, scarifying and cleaning while the concrete is between its initial and final set shall be done. Great care shall be taken in performing this work to avoid removal of too much mortar and weakening of the surface by loosening of aggregate.

d) Concrete surfaces, upon which new concrete is to be placed, shall be cleaned and wetted, immediately before placement of the concrete. The bonding shall be with mortar having the same cement-sand ratio as that of the concrete being placed. Cost of the same will be deemed to have been included in the rate for concrete. However, no bonding mortar is required when green cutting technique is adopted for surface preparation.

Similar treatment shall be given at vertical construction joint.

6.12.5 WORKMANSHIP OF CONCRETE

Workmanship shall be conforming to relevant Indian Standards and good engineering practices. The mix proportioning shall have prior approval of the Engineer. Concrete shall be produced at fully automatic batching plants. In case, where the tilting drum mixer is used, adequate and accurate weight batching arrangement shall be provided. Tilting drum mixer shall be fully discharged before taking new batch. Partly set concrete shall be immediately removed. On completion of work the mixer as well as all other equipment shall be thoroughly cleaned.

6.13 SELF-COMPACTING CONCRETE (SCC)

Self-Compacting Concrete shall conform to European specification for Self-Compacting Concrete – Specification, Production and Use. All the ingredients of SCC are same as that of normal concrete, except Viscosity Modifying Agent (VMA) as an additional ingredient Quality of all the ingredients shall be the same as that for normal concrete. VMA shall be added to increase shear resistance of the concrete. All the test

equipment as well as desired parameters for fresh concrete shall be as detailed in European specification. After the mix proportion is finalized, adequate mock-ups shall be done, to ensure consistent quality of self-compaction. SCC may be used for casting all the structural elements of the plant buildings. It shall be kept in mind that formwork design shall be carefully done for SCC, as the SCC remains in liquid form for a longer period. As far as possible, pumping shall be resorted to. All other requirements for testing shall be the same as that of normal concrete, specified elsewhere in these specifications.

Properties of the fresh concrete are to be checked as per the provisions in the European specification. The desired parameters are given in Table 6.22. Testing methods and testing equipments like flow table, V-funnel, L-box, U-box, fill box and segregation resistance test shall be as per European specification. The tests to be carried out to establish various properties are given in Table 1.24. Once it is established that the mix proportion is meeting the desired parameters and after establishing the consistency of the results, the flow table test and V- funnel test are to be conducted at production point and placement point as a quality control measures. For hardened concrete, the tests specified in Table 6.20 are to be carried out. These Two (2) tests shall be conducted for first 3 transit mixers and subsequently one for every set of 5 transit mixers.

TABLE 6. 22
PARAMETERS FOR SCC

Sl. No.	Test	Unit	Minimum	Maximum
01	Slump flow	mm	650	800
02	T50 cm slump flow	Sec	2	5
03	“V” funnel	Sec	5	15
04	‘L’ box	h_2 / h_1	0.8	1.0
05	‘U’ box	$(h_2 - h_1)$ mm	0	30
06	Fill box	%	90	100
07	Segregation	%	-	20

TABLE 6.23
PROPERTIES TO BE ESTABLISHED BY TESTS

Slump flow test	Stability of mix (Cohesiveness)
T-50 cm time slump flow test	- do -
V-funnel test	Flow ability
L-Box test	Passing ability
U-Box test	- do -
Fill box test	Filling ability
Segregation Resistance test	Segregation

6.14 MATERIAL TESTING LABORATORY

The contractor shall establish a state of the art material-testing laboratory at site for testing of all the concrete ingredients, fresh concrete and hardened concrete. Fully automatic cube testing machines of adequate capacity and numbers shall be installed in the laboratory. Facilities for water permeability test as per DIN 1048 and Rapid Chloride Permeability Test (RCPT) as per ASTM-C-1202 shall also be available in the laboratory. Laboratory pan type mixer shall be available with the Contractor.

7. FORM WORK

7.1 SCOPE

The work covered under this section shall include the providing, erection and removal of formwork for all normal, and pre-cast concrete in walls, columns, foundations, slabs and beams, including its supporting members.

7.2 GENERAL

7.2.1 The formwork shall consist of but not limited to shores, bracings, sides of beams, columns, walls, rafts and bottom of slabs including ties, anchors, inserts, hangers, false work, wedges, etc. complete which shall be properly planned for the work. For the floors, supports can be taken from the floor down below with prior permission of the Engineer. Wherever required, provision shall be made to support the floor shuttering by means of trusses, which shall be spanned from the nearby walls/columns. Wherever specified, the left-in shuttering of adequate capacity shall be used.

7.2.2 The Contractor shall prepare, before commencement of actual shuttering work, design and drawing for formwork and centering and get them approved by the Engineer well in advance before fabrication and erection of formwork. Formwork shall be designed to fulfill the following requirements.

a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

b) Made of suitable materials.

c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

d) Capable of withstanding without deflection the worst combination of self-weight, reinforcement and concrete weight, all loads including lateral pressure on vertical surfaces and dynamic effects arising from construction and compacting activities, wind and weather forces.

e) Capable of easy striking without shock, disturbance or damage to the concrete.

f) Soffit forms capable of imparting a camber if required.

g) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete, design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

7.2.3 Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for on the drawings. Ample struts, walers, braces, etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Unless otherwise specified all forms in contact with concrete having F-3 finish shall be plywood panel formworks. Forms will be firmly bolted to previous pour of concrete. No through bolts embedded in concrete will be permitted in any underground structures. Threaded mild steel sleeves designed for holding in concrete and standard coil nuts/cone anchors shall be embedded in preceding concrete pours to anchor tie rods on lower end, while on the other end tie rods shall be provided beyond the lift under construction. Tie arrangement with baffle plate within the concrete may also be used as substitute for through tie with prior approval of the Engineer. The Contractor should finish all the coil nuts by dry packing. The recesses, if any, formed by removable timber wedges shall be filled with caulking compound or Epoxy mortar if depth is less at the Contractor's own cost. Formwork for removable hatchways and plugs shall be installed in place wherever possible. Back form for sloping concrete surfaces shall be provided as decided by the Engineer at no extra cost.

7.3 DESIGN AND FIXING OF FORMWORK

The formwork shall be designed and fixed to meet the tolerance in various areas as specified elsewhere in this specification. All floors and beam centering shall be crowned not less than 8 mm in all directions for every 5-meter span. Forms in contact with concrete shall be free from adhering grouts, projecting nails, splits or other defects. Formwork shall be so designed and erected with the forms for slab so that the sides of beams, columns and walls may be removed first, leaving the formwork to the soffits of beams and their supports in position. Where formwork for column is erected for its full height, one side shall be left open and built up in sections as placing of concrete proceeds, if so directed by the Engineer.

7.4 DESIGN LOADS

7.4.1 Unless prior approval in writing has been received from the Engineer all vertical wall forms shall be constructed for the minimum pressure as per CIRIA/ European Guidelines recommendations. The Contractor shall ensure that the constructions of the forms are adequate for all concrete placing condition and all the applicable CIRIA/European Guidelines recommendations are followed. However, in case of self-compacting concrete, the entire height of the pour shall be considered to be in fluid state and the lateral pressure shall be w x h, where "w" is the unit weight of green concrete and "h" is the height of pour.

7.4.2 All horizontal forms shall be constructed for pressures from the dead load of concrete including embedment and a minimum live load of 200 Kg/sq.m.

7.4.3 Forms constructed for retaining heavy concrete shall be built for pressures which have been increased by the ratio of the unit weight of heavy concrete to normal concrete.

7.4.4 Further, the formwork shall be designed to withstand all pressures arising out of placement of concrete using pumps, incidental loads if any and live load on the working platforms.

7.4.5 The form work shall be designed and fixed to meet the tolerances in various areas specified by the Turbine Manufacturer or as specified in the relevant drawings

7.5 TEMPORARY OPENINGS

Temporary openings, which can be conveniently closed, shall be provided at the base of the columns and wall forms and other places necessary to facilitate cleaning, inspection and vibration of concrete. Immediately before concrete is placed the forms shall be made sufficiently rigid and tight, thoroughly cleaned properly treated and free from foreign material. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

7.6 MATERIALS

7.6.1 Materials for the formwork shall be of plywood, formed steel plates, timber form covered with steel sheets, oil tempered hard board. Sliding forms and slip form shall be used for tall structures where specified and after approval by the Engineer. The supporting system shall be either adjustable props made of mild steel pipes for heights up to 6 meter or composite columns fabricated using M.S. Structural steel members.

7.6.2 Shuttering arrangement for concreting shall be of 12 mm/16 mm thick plywood backed with steel/DOKA framework and supports of horizontal and vertical walers connected to turn buckles. In case steel shuttering plates are used for formwork, the joints between the panels shall be sealed with suitable foam to make the formwork leak tight. Flat bar at top of soldier to be provided for maintaining thickness. Supports shall be rigid and strong enough to withstand effect of vibration without any deflection, bulging, distortion or loosening of its supports and shall be so as to prevent loss of slurry from the concrete. Plywood used shall be waterproof plywood conforming to IS: 4990. Test certificates from the manufacturers will be obtained and verified. Form strips or any other suitable sealing tapes will be used to prevent loss of slurry through the joints of formwork.

7.6.3 Suitable working platform will be provided for execution/ inspection of reinforcement, embedded parts and concreting.

7.7 CENTERING REQUIREMENTS

Centering using steel tubular props, H frames, built-up sections, with provisions to adjust heights of props shall be used and they shall be to true levels and rigid. They shall be adequately braced horizontally and vertically. For faster construction, quick strike decking system/ Acro/Doka systems shall also be used for shuttering supported

on floors below, vertical props shall be so supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering. Bamboos or wooden poles shall not be used as props or cross bearers. Centering supported on structural steelwork shall also be designed for the conditions mentioned above.

7.8 TIE RODS

As far as possible MS tie rods left in type shall be used for supporting all forms. Retrievable type can also be used with prior approval of the Engineer. Tie rods shall have provisions for removal of a section of each rod at surface of the concrete to a depth of approximately 50 mm. All holes left by the removal of conical nuts or other removable fixtures embedded in the face of the concrete shall be filled and finished with sand-cement mortar in a manner specified in the finishing specification. Threaded inserts embedded on each face of the wall be cut for attaching the forms to previously placed concrete and when permitted shall be out off flush with the face of concrete or countersunk, filled and finished as required by the Engineer in the manner specified in the finishing specification. Measures shall be taken to prevent rust stains on concrete.. Through left-in Tie rods shall be permitted only upon approval of the Engineer.

7.9 FORM OIL

7.9.1 *Use of form oil shall not be permitted on the* surfaces, which require painting. If the Contractor desires to use form oil on the inside of the formwork of the other concrete structures, a non-staining mineral oil or other approved oil may be used provided it is applied before placing reinforcing steel and embedded parts. Such form oil shall be insoluble in water and not injurious to concrete and shall not become flaky or be removed by rain or wash water. Form oils that retard the setting of concrete shall not be used.

7.9.2 All excess oil on the form surface and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil, forms shall be thoroughly cleaned of dried splatter of concrete from placement of previous lift.

7.9.3 The Contractor shall clean the concrete surfaces from any leftover form oil at his own cost if form oils are used.

7.10 SUSPENDED FORMWORK

7.10.1 In certain areas, as identified by the Engineer, metal decking/ and supported on structural steel framework shall be used as self-supporting shuttering as an alternative to the conventional shuttering in places where the area below has to kept free of scaffolding and centering works. The fixing of metal sheets to structural steel members shall be done by bolting / welding or any other alternative as advised by the Engineer .

7.10.2 Plate inserts may be embedded in the sidewalls during concreting, from which bracket supports can be obtained. Structural steel built-up sections or trusses shall be used for

supporting the formwork. The Contractor shall submit the design and detailed drawings for the above scheme for the approval of the Engineer. The scope of work shall include design, fabrication, erection and dismantling of the supporting structure.

7.11 CHAMFERS AND FILLETS

Unless shown on drawings or elsewhere to the contrary, all corners and angles shall be formed with 45 Degree mouldings to form chamfers or fillets on the finished concrete. The standard dimension of chamfers and fillets, unless otherwise detailed or specified shall be 25 mm by 25 mm. For heavier work, chamfers or fillets may be 40 mm to 50 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the mouldings shall be planed or surfaced to the same texture as the forms to which it is attached. Unit rates quoted shall include providing the chamfers as specified or shown in the drawings.

Vertical construction joints on faces, which will be exposed at the completion of the project, shall be chamfered as above except where not permitted by the Engineer.

7.12 JOINTS

Joints in forms shall be truly horizontal or vertical unless otherwise specified and shall be sufficiently tight to prevent any leakage of cement slurry to avoid formation of fine or blemish. Faulty joints shall be sealed as directed by the Engineer. Suitable devices shall be used to hold adjacent edges together in accurate alignment. The Contractor shall use sealing tapes to avoid leakage of slurry through the formwork joints. On removal of forms the Contractor shall finish marks left by sealing tapes so as to merge with other concrete surface. The Contractor shall take care to maintain symmetry in formwork in slabs, walls, columns etc. so as to give a pleasant appearance to finished concrete surface. All forms shall be so made that they can be removed without hammering or prying against the concrete.

7.13 REUSE OF FORMS

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary, repaired or re-oiled before resetting. Formwork shall not be used/ reused, if declared unfit or unserviceable by the Engineer.

7.14 CLEANOUT PROVISIONS

Forms with limited working space within, shall be provided with temporary clean-out doors or openings for cleaning, washing, blowing and removal of water, wood chips, trash etc.

7.15 WORKING PLATFORM

The Contractor shall provide safe working platform for workmen, when working above ground level. Safe method of approach shall be provided to reach locations above ground level. Handrails shall be provided for all working platforms. Hanging platforms

shall have safety net provisions. All ladders shall have handrails and shall not be kept vertical. All platforms, ladders, handrails etc. shall be firmly secured to ground or on supports. No loosely supported ladders or platforms shall be used in the work. All ladders and platforms shall have a kick plate 150 mm high either MS or wooden board for safety of personnel. Ladders and platforms shall be periodically cleaned of loose debris etc.

7.16 REMOVALOF FORMS

7.16.1 In the determination of time for removal of forms, consideration shall be given to the location and character of the structure, the weather and other conditions including the setting and curing of the concrete and materials used in the mix.

7.16.2 Forms and their supports shall not be removed without approval of the Engineer. Improper methods of removal of formwork likely to cause overstressing or damage to the concrete shall not be used. Supports shall be removed in such a manner so as to permit the concrete to uniformly and gradually take the stress due to its own weight.

7.16.3 The supports can be reinstated in anticipation of abnormal conditions. Re-propping of beams shall not be done except with the approval of the Engineer.

7.16.4 The minimum period for removal of forms shall be as mentioned below. However, The seven-day test results shall be as per IS: 456 (latest revision). If the strength requirements are not met with, the formwork shall be removed as per the instructions of the Engineer.

TABLE 7.1

MINIMUM PERIOD FOR REMOVAL OF FORMWORK

Sl. No.	Class of Structures	Earliest Concrete age at stripping for placing Temperature above 20 deg. C	
		Where ordinary Portland cement is used	Where mineral admixture is used
1.	Walls, Columns & Vertical sides of Beams	24 to 48 hrs. as decided by the Engineer	48 to 96 hours
2.	Slabs (props left under)	3 days	7 days
3.	Beam soffits (props left under)	7 days	14 days
4.	Removal of props to slabs		
	For thickness above 300mm		
	a) Spanning upto 4.5M	14 days	21 days
	b) Spanning over 4.5M	21 days	28 days
	For thickness upto 300mm		

	a) Spanning upto 4.5M	7 days	14 days
	b) Spanning over 4.5M	14 days	21 days
5.	Removal of props to beams and arches		
	a) Spanning upto 6M	14 days	21 days
	b) Spanning over 6M	21 days	28 days
6.	Cantilever construction	Not until adequate fix-ity is developed subject to a min. of 10 days	Not until adequate fix-ity is developed subject to a min. of 21days

7.16.5 For rapid hardening Cement Concrete 3/7 th of the period specified for ordinary Portland Cement will be sufficient subject to the minimum period of 24 hours.

7.16.6 Striking shall be done with utmost care to avoid any damage to concrete surfaces or any projections on it and without shock and vibrations, by gently easing the wedges/jacks. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and made good as approved.

7.16.7 Tie rods, clamp form bolts etc., which must be entirely removed from the walls or similar structure, shall be loosened not sooner than 24 hours after the concrete was deposited. Works damaged due to premature or careless removal/withdrawal/ loosening/striking of forms shall be reconstructed at Contractor's cost.

7.17 STOPPER FORMWORK

Stopper formwork (Bulkhead) shall be provided at all vertical construction joints. Such formwork shall be leak-tight and shall not allow leakage of cement slurry. Wherever specified in the drawings, gas barrier/water stopper shall be provided in the stopper shutter. In addition to the erected stopper, emergency stopper formwork shall be kept ready before starting large concrete pours, with provision for gas barrier/water stopper if required. All stopper formwork shall be measured and paid in the item of formwork only.

7.18 SLOPING FORMWORK

The bottom formwork shall be made out of plywood with wooden backing members. For slope above 15 Degree with the horizontal it is recommended to have plywood formwork for the top surface and supported on steel or wooden truss. These shall be divided into panels, which shall be fabricated in the shop to the required profile. The bottom of truss will be closed by plywood formwork at the time of concreting. Subsequently further closer formwork for the top surface will be extended after concreting and compaction of the lower portion The entire formwork shall be supported on structural steel/scaffolding supported on a firm base.

7.19 FORMWORK FOR SELF COMPACTING CONCRETE

The formwork shall be made out of plywood with wooden backing members. These

shall be divided into panels, which shall be fabricated in the shop to the required profile. Special care should be taken so that there is no gap in the formwork joints so as to ensure not leakage of slurry due to increased workability and slump achieved by using appropriate admixtures. The lateral green concrete pressure on the formwork shall be governed as per Para titled "DESIGN LOADS" of this specification.

7.20 POCKETS FOR FOUNDATION BOLTS

Pockets for foundation bolts shall be made out of plywood or timber. These shall be made slightly tapered for ease of removal. The bottom of such formwork shall be necessarily closed so as not to allow entry of concrete from bottom. The timber pocket may have to be broken to withdraw after concreting. Templates shall be provided wherever required or as directed by the Engineer.

7.21 CURVED FORMWORK

This shall cover all such formwork, which is curved in plan. The formwork shall be fabricated to the required curvature at shop before use. Mismatch if any at site, shall be rectified by cutting or replacing the panel/members.

7.22 FORMWORK FOR PRE-CAST CONCRETE WORKS

All pre-cast units shall be cast in a suitable yard, bed or platform with firm foundation and free from wind. The platform shall have a smooth plaster finish. The yard shall be fenced and shall have a curing tank of adequate size and capacity. The Contractor shall be responsible for the accuracy of the level and shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or printed on each unit. Each unit shall be concreted in one operation. Reinforced concrete members shall be marked to indicate the upper surface.

The form shall be of steel sheets with only rigid steel frames. All components of formwork shall be so held that during casting there is no deformation of the form resulting in the concrete units not confirming to dimensions indicated in the drawings. The shuttering shall be made with a tolerance of (±) 3 mm in all directions.

The side shutters shall not be struck in less than 24 hours for ordinary Portland cement after concreting and no pre-cast unit shall be lifted during striking the form.

7.23 METAL DECK SHEETING WORKS AS LEFT IN SHUTTERING

7.23.1 GENERAL REQUIREMENT

This part of the specification covers the technical requirements for deck sheeting to be used as left in shuttering for floors & roofs. Supply and installation of the deck sheeting shall be done by same agency. During handling / stacking, if any damage is done to sheet like distortion of edges, scratches on sheet etc., then such damaged sheet shall stand rejected and shall be immediately replaced by the contractor.

7.23.2 MATERIAL

7.23.2.1 Troughed permanently metal decking sheet for Floor / roof decking shall be made by steel feed material of minimum 1.0 mm (bare metal thickness i.e. metal thickness excluding thickness for coating and galvanizing) galvanised to grade 275 as per as per IS 277, of minimum yield strength of 250 Mpa of drawing grade as per IS 513 of approved profile, sectional properties.

7.23.2.2 For metal decking the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 over a span of 1.5 m under total super imposed loading (DL +LL) of minimum 1000 kg per Sq.M.

7.23.2.3 The maximum spacing of the fasteners shall be 390 mm c/c along the length of purlins/runners. However exact spacing shall be as per the design done by the bidder for the fasteners considering the wind load, self-load and other associated loads. Minimum diameter of the fastener shall be 5.5 mm and at least 3 nos. of fasteners shall be used per sheet.

7.23.2.4 Percentage elongation of the mild steel sheet having minimum yield strength of 250 MPa, shall be 23% as per IS:2062.

7.23.3 INSTALLATION AND FIXING

a. The sheeting shall be fixed as per the approved drawings. Sheets shall be supplied in required sizes (based on supporting member spacing) according to the cutting schedule. Generally cutting of sheets to length shall not be permitted at site. Specific approval under exceptional circumstances shall be obtained before cutting of any sheet at site. Power tools shall be used for cutting. Cutting and trimming of small openings which were not finalised at the time of working drawings can be allowed at site. Wherever possible, site cut edges shall be concealed at laps or with flashings. Suitable steel members for stiffening shall be provided at the cut edges. No gas cutting shall be done on the sheet. If any sheet is found with gas cut mark, same shall stand rejected and shall be immediately replaced.

b. Distorted, blemished or water stained sheets shall not be used.

c. Before installing decking sheet, it shall be ensured that the purlins / supporting members are in true planes, correctly placed and securely fixed.

d. Side and end laps of the sheets shall be made weather proof by securing them with the fasteners not less than 4.0mm dia with 2.0 mm thick neoprene washer. Maximum spacing of the fasteners shall not to exceed 500 mm.

e. Precautions shall be taken during the erection of the sheets to ensure that partially erected decking sheets are protected during inclement weather and damage at all times.

f. Side and end of decking sheet shall be located and positioned in such a manner as to

provide the maximum weather protection taking into account the direction of the prevailing wind.

g. Length of the sheet shall be such as to cover minimum 3 span purlin/ supporting members spacing.

h. The roof decking sheets shall be fixed to the purlins/ supporting members with the help of self drilling and tapping type fasteners and neoprene washers.

i. Sheets shall be laid over the supporting members/ purlins with a minimum bearing of 50 mm and end projection of 75 mm at lap joints.

j. End and side laps between the sheets shall be sufficiently large to ensure the weather tightness. In no case, the end laps shall be less than 150 mm and side laps less than one trough length with proper weather tight arrangement.

k. As required the suitable shear connectors shall be provided on deck sheeting for proper shear transfer between sheet & floor/ roof concrete.

7.24 CONSTRUCTION JOINTS & GROOVE FOR CAULKING

These shall provided as shown in the approved drawings or as desired by the Engineer. A trapezoidal groove tapering from the face of the wall to inside will have to be provided on containment walls and roof at all construction joints. For construction joints in thin sections a steel cover plate exposed from one side of the surface will be provided replacing the water stop within the thickness and concrete will be cast against the plate. Suitable grooves will be provided at the junction of the plate and the concrete. Also embedded parts passing through the wall will be provided with grooves around its periphery on the containment walls. All such grooves shall be caulked by the flexible polysulphide compound or epoxy mortar as directed by the Engineer.

7.25 TOLERANCES

The following tolerances are permitted unless otherwise mentioned in the relevant drawings. The tolerances shall be taken as the departure from the true position at any point after completion of the structure.

Sectional dimensions	:	(±) 5 mm for cast-in-situ concrete.
Plumb	:	5 mm in 5 m but not cumulative. Tolerance in various sections should be compensatory and not cumulative
Levels	:	2 mm before any deflection has taken place for both cast-in-situ and pre-cast works.

Tolerances for climbing type of form work. Variation in walls: Not more than (+) 3 mm.

Total deviation at any point of climbing form / other formwork measured in horizontal plane with respect to the projection of a corresponding reference point at the base of the structure. (Total deviation consists of translational and rotational components.) : 3 mm per 6m height unless specifically required otherwise.

Latest computerised survey instruments shall be used for checking the verticality and alignment of the form works.

7.26 SUBMISSION OF CONTRACTOR'S SCHEME

Bidder shall submit along with his tender the scheme for shuttering, centering, scaffolding for important elements. These should be supported by preliminary drawing and design calculations. Final drawing shall be submitted before start of work.

The scheme submitted by the Contractor should be for all the different type of centering and shuttering schemes proposed and should be so elaborate keeping in mind the entire cross-section of the respective structures in general. The scheme should be such that the construction of one part of any building should not hinder the work on the other parts and keeping in mind the construction schedule.

For centering and shuttering of walls, columns, beams & slabs all the working drawings, details of erection methods calculation of stress and of deflections shall be supplied to the Engineer for approval at least six (6) months in advance of erection.

7.27 ALTERATIONS AND MAINTENANCE

Any modification that the Engineer may require shall be made by the Contractor. Notwithstanding the approval of or alteration suggested by the Engineer in the submitted design for any of the temporary work etc., the Contractor shall remain wholly and entirely responsible until the final acceptance of works, for the efficiency, security, safety and maintenance and for all obligations and risks in regard to such work specified or implied in the contract. The Contractor shall reinstate the same at their own cost, should any mishap or accident occur causing damage or injury thereto, subject however to such provisions of the conditions of contract as may be applicable in the case of such damage or injury.

8. WATERPROOFING OF UNDERGROUND CONCRETE STRUCTURES

8.1 SCOPE

This specification covers waterproofing of underground concrete structures viz. basement, sump, pit, tunnel and trenches against ground water.

The specification described here covers material description, physical and mechanical properties, testing, applicable codes and standards, acceptance criteria, surface preparation, placing in position, lapping and QA requirement etc of water proofing treatment of basement slab and walls.

8.2 GENERAL REQUIREMENTS

As a general guidance, the provisions contained in the contract shall be followed unless otherwise mentioned. Considering safety requirement, Nuclear Power Plant structures should meet special requirement regarding leak tightness.

The contractor shall do the proper concreting so that concrete is water tight in itself without waterproofing treatment. Quality control of concrete construction shall include inspection of preparations for concreting, mixing, transportation, placement, compaction, curing and protection.

The work of waterproofing of underground concrete structure shall be entrusted by the contractor to expert agency approved by NPCIL. The specifications of waterproofing mentioned here are generic in nature. The Contractor shall submit the detailed specification of waterproofing for NPCIL's approval.

8.3 MATERIAL

The plasticized PVC membrane shall be minimum 2.0 mm thick, single ply, twin colored preformed flexible membrane. The single ply plasticized PVC membrane shall be thermoplastic membrane manufactured by co-extrusion process. The membrane shall be of twin colour to provide visual indication of damage, due to any movement or any other reason. The sheet shall be minimum 2 meter wide and appropriate length to minimize the number of joints. The compartmentalization shall be done using specified size of water stop to confine any accidental damage within 100 square meters. All lap joints shall be tested for water tightness upto 2 Kg/sq cm pressure prior to concreting. The membrane shall be suitable for defect free installation on all type of surfaces viz. horizontal, vertical and overhead and it shall be loosely laid (unbounded) to act independent of structural movement. Adjacent sheets shall be laid with an overlap of at least 80 mm.

The PVC membrane used for waterproofing membranes shall exhibit the following properties.

PROPERTY	**TEST METHOD**	**UNIT**	**ACCEPTANCE VALUE**
Thickness	UNI EN 1849 -2	mm	Minimum 2.00 mm
Specific weight	UNI EN 1849 -2	kg/m2	2.600
Ultimate Tensile strength	UNI EN ISO 527-3 Transverse Machine direction	 N/mm2 N/mm2	 Minimum 14.9 N/mm2) Minimum 15.2N/mm2)
Ultimate Tensile Strength	UNI EN ISO 527-3 Transverse	 N/mm2	Minimum 14.9 N/mm2) Minimum 15.2N/mm2)

(Ageing by complete immersion in ground water for 16 months at 50 ^{0}C)	Machine direction	N/mm2	
Elongation	UNI EN ISO 527-3 Transverse Machine direction	 % %	 min 280 (-30%) min 280(-30%)
Mean Tensile Strength Variation	DIN 53455	%	3.5
Impact strength	DIN 16726 - 5.12	mm	> 600
Puncture resistance	DIN 16726 - 5.12	mm	> 1000 mm
Hydrostatic pressure resistance (6 hours at 5 bar)	UNI EN 1928 meth.B		Waterproof
Tear resistance	ISO 34 /ASTM D624	MPa	> 45
Resistance to static punching (CBR)	UNI EN ISO 12236	N	> 1700 N
Root resistance	DIN 4062		No penetration
Fire Behaviour	EN ISO 11925-2		Class E

For Sub-soil applications the chemical resistance of the PVC membranes shall be as fully resistant to the chemicals along with the respective compositions as listed below as per ASTM D 6943 (i.e. complete immersion of sample in respective solutions for 15 days).

CHEMICAL NAME	**NATURE OF CHEMICAL**	**% CONCENTRATION**
Sulphuric Acid	Inorganic Acids	≤ 25
Sulphurous Acid	Inorganic Acids	≤ 6
Nitric Acid	Inorganic Acids	≤ 5
Benzoic Acid	Organic Acid	≤10
Acetic Acid	Organic Acid	≤10
Oxallic Acid	Organic Acid	≤ 25
Phthalic Acid	Organic Acid	≤ 25
Tartaric Acid	Organic Acid	≤25
Citric Acid	Organic Acid	≤ 25
Ammonium Hydroxide	Inorganic Bases	≤ 5
Potassium Hydroxide	Inorganic Bases	≤ 5
Sodium Hydroxide	Inorganic Bases	≤ 10
Chlorides	Salt Solutions	≤ 25

Sulphates	Salt Solutions	≤ 25
Nitrates	Salt Solutions	≤ 25
Soap Solution	Salt Solutions	≤ 25
Drinking Water	Salt Solutions	Any Concentration

8.4 THICKNESS & SPECIFIC WEIGHT OF SHEET

The thickness of the single ply plasticized PVC membrane shall be 2.00 (minimum as per UNI EN 1849). The specific weight of 2.0 mm thick single ply plasticized PVC membrane test piece shall be determined in mass per unit area.

8.5 TENSILE STRENGTH & ELONGATION TEST

The tensile strength and elongation requirement shall be as per UNI EN ISO 527-3. In this test, dumbbell shaped single ply plasticized PVC test pieces are cut using the standard dumbbell die are stretched in a tensile testing machine at a constant rate of traverse of the driven grip. Readings of transverse loads and elongation are taken as required during the uninterrupted stretching of the test piece and when it breaks. For the tensile strength of the joints they are subjected to varying tensile stresses for the overlap joints as per ASTM D638.

8.6 PUNCTURE RESISTANCE

The puncture resistance requirement shall be as per DIN 16726 - 5.12. This is measured using the truncated cone test, in which truncated cones are used as puncture points. The heights of the truncated cones are varied to determine the critical cone height, which is the height at which the puncture occurs for a given pressure. The minimal permissible height for a 2.0 mm thick single ply plasticized PVC membrane used for waterproofing in case of basements is >800 mm.

8.7 HYDROSTATC PRESSURE RESISTANCE

The hydrostatc pressure resistance requirement shall be as per UNI EN 1928 meth.B. In this test the lateral hydrostatic pressure is exerted on below-grade foundations and slabs on grade by an elevated water table. Tests to quantify resistance to the passage of water should be specific as to the maximum pressure the membrane must be capable of withstanding. In case of single ply plasticized PVC membranes the minimum amount of pressure that the membrane can withstand is tested for a water table of 60mts as per the code. Subjected to these conditions there should be no penetration of water as per the specifying needs.

8.8 ROOT PENETRATION RESISTANCE

Root resistance is tested for single ply plasticized PVC waterproofing membrane through the composition of the membrane which provides an impenetrable barrier to root growth. Root resistant 2.0 mm thick single ply plasticized PVC membrane is quicker to install than separate waterproofing and root barrier layers.

8.9 TEAR RESISTANCE

This test method measures the force per unit thickness required to rupture, initiate, or propagate a tear through a sheet of 2.0 mm thick single ply plasticized PVC membrane. This testing is done so that the specified waterproofing membrane does not fail in service due to the generation and propagation of a special type of rupture called a tear. Tear strength is calculated as T= F/d, where T is the tear resistance, F is the load acting on the membrane and d is the thickness of the membrane. Tear strength of 2.0mm thick single ply plasticized PVC membrane should at least be 45MPa.

8.10 STATIC PUNCHING RESISTANCE

CBR Puncture is an index of puncture resistance that measures the force required to push a flat ended plunger through a 2.0 mm thick single ply plasticized PVC membrane. Instead of an 8 mm diameter probe with a beveled edge; this test utilizes a 50mm diameter, flat-ended probe (plunger) that is pushed slowly through the PVC membrane. The relatively large size of the plunger provides a multidirectional force on the PVC membrane and simulates big stones pressed onto the PVC membrane laying a relatively soft sub-base. The minimum value for a static punching resistance should be at the very least of 1700 N for subsoil applications.

8.11 FIRE RESISTANCE

This test determines the ignitability the specimen is subjected to direct impingement of a small flame at the edge or at the surface. The test specimen of size 250 mm × 90 mm is attached vertically on a U shaped specimen holder. A propane gas flame with a height of 20 mm is brought into contact with the specimen at an angle of 45 °. For subsoil applications of 2.0 mm thick single ply plasticized PVC they should belong to Class E as per the ISO 11925-2 (Reaction to fire tests-ignitability of products subjected to direct impingement of flame-Part 2:single flame source test).

8.12 TESTING

For acceptance of material listed in above table, Manufacturer Test Certificate (MTC) from manufacturer confirming to above specified properties shall be submitted to NPCIL. However, membrane supplied from each batch shall be got tested for Thickness, Ultimate Tensile Strength, Elongation & Puncture Resistance. Testing of the membrane shall be carried out by the contractor as per approved QAP in laboratories like IITs, ICT etc. or other Government approved/ NABL accredited laboratories as acceptable to NPCIL as per above mentioned relevant standards at no extra cost to NPCIL.

8.13 PACKAGING SHIPMENT AND STORAGE

Materials delivered at site shall be clearly marked with legible and intact labels with manufacturer's name, brand name, product identification and batch number. The products (adhesives etc.) shall be in original, unopened containers.

Materials shall be stored in areas where temperatures conform to manufacturer's recommendations and instructions. All materials shall be stored in covered clear away from reinforcements, coarse aggregates and heavy engineering activities at site. All the materials like membranes, sealants etc. shall be kept away from sources of ignition.

All empty containers of various chemicals employed, left over chemicals shall be disposed off; in a safe manner on a dumping site approved by the site authorities.

All personnel of the applicator should wear all safety gears like gloves, helmet, goggles etc during installation.

8.14 INSTALLATION AGENCY

The works shall be carried out only by trained and certified applicator of the specialized agency carrying water proofing treatment/ membrane supplier.

8.15 INSTALLATION OF MEMBRANE

The plasticized PVC membrane shall be fixed on PCC surfaces strictly as per the detailed application guidelines of the manufacturer. Broadly the installation steps shall include

- Removal of Sharp protrusions
- Installation of Geo textile made of needle-punched 100% pure polypropylene yarns, with a minimum weight of 300 gsm.
- In case of Vertical walls, installation of roundels with mechanical fixtures.
- Laying of plasticized PVC membrane with specified lap joints
- Welding of Joints and testing for water tightness up to 2 Kg/Sqcm
- Water tightening of Pile heads/ rock anchors etc as applicable
- Compartmentalization of the PVC membrane using PVC surface water stops
- Laying of Second layer of Geo textile.
- Laying of Protective screed on horizontal surfaces
- Laying of minimum 25mm thick Protective boards / 115 thick Brick wall protection (the protective board shall be used in case of back filling done with soil / crushed sand , having no boulder/aggregate bigger than 80mm size) for the vertical walls.

A detailed scheme shall be submitted by the contractor including the layout of PVC water stop arrangement and injection ports etc (if proposed) for NPCIL approval prior to its application.

The main contractor shall ensure that all areas of the finished basement waterproofing system shall be protected from site related work traffic and other trades until completion of all works.

Adequate temporary protection shall be provided over the installed membrane during the works program, particularly at temporary walkways, access points to the basement, concreting material stockpiles etc. in order to prevent damage.

8.16 PREPARATION OF THE SUBSTRATE

The substrate shall be PCC concrete of sufficient thickness (minimum 50 mm) to ensure a firm substrate that will not crack or deform under normal trafficable conditions during waterproofing installation, and structural concreting operations. It should be smooth, free from debris and other irregularities, which may puncture and damage the waterproof liner.

The surface will be made clean, dry, smooth and free of contaminants such as grease, animal fats, coal tar and oil based products. Accumulation/ ponding of water shall be removed from the work surface prior to installing the system.

All horizontal or vertical surfaces should be covered with a uniform adjustment layer using Non-Woven Geotextile. It has the purpose of ensuring the uniformity of the substructure in order to avoid irremovable debris or other roughness in the underlying layer which may cause damage, perforate or punch, the waterproof layer.

8.17 WATERPROOFING SYSTEM FOR BASEMENT RAFT SLAB

The 2.0mm thick single ply twin colored plasticized PVC loosely laid membrane waterproof system should be installed over the hardened well leveled surface of the PCC overlaid with first layer of Geotextile. The Geotextile shall be resistant to micro-organisms, needle-punched 100% pure polypropylene yarns, with a minimum weight of 300 gsm. The PVC membrane system shall be compartmentalized using PVC surface water-stop maximum size of compartmentalization shall be limited to 100 sq m). The PVC water stop used for compartmentalization shall be minimum 320mm wide, min thickness of 2.5mm and shall have minimum 4 ribs of 15 mm depth. These PVC water stops shall be welded with PVC membrane by hot air welding. The membrane shall be further covered with second layer of Geotextile ensuring no gaps in the Geotextile. The geotextile should be checked prior to laying of protection screed.

After checking all the joints & any visible damage, second layer of geotextile shall be laid over the member followed by laying of minimum 50mm thick layer of protection PCC (Minimum Grade M20) screed. The damage if any found, shall be recorded and the necessary patch repairs shall be conducted before laying of second layer of geotextile and protection layer.

8.18 WATERPROOFING SYTEM FOR VERTICAL/RETAINING WALL

The first layer of Geotextile Membrane shall be laid over the hardened well leveled surface. Over the Geotextile membrane 2.0mm thick single ply, twin colored, and plasticized PVC membrane waterproofing system shall be installed using rondels having maximum C/C spacing 1.0m .The rondels are provided to anchor & hold the Membrane at its position. The membrane is to be protected after installation with a 300gsm geotextile followed by protective layer of 25 mm thick expanded polystyrene boards (in case of back filling done with soil / crushed sand, having no boulder/aggregate bigger than 80mm size) or 115 mm thick brick wall. The PVC

membrane system shall be compartmentalized using PVC surface water-stop at required locations, based on the site requirements (maximum size of compartmentalization shall be limited to 100 sq m).

8.19 CHECK FOR MEMBRANE TO MEMBRANE JOINT

Two adjacent membranes shall be welded using hot air welding. It shall be a double seam weld to maximum clear length of the membrane installed; double seam weld shall allow pressure testing of every length of joint. The double seam joint shall be tested to a pneumatic pressure of maximum 2 bars kept for minimum duration of 8 minutes. The loss of pressure after holding for 8 minutes shall not exceed 20%.

Wherever the double seam welding machine cannot be used, the single seam welding shall be done after obtaining prior permission from engineer, in such case the weld width shall be preferable 40mm, but shall not be less than 20mm in any case. The single seam weld shall be tested using a seam probe hook to check for any opening in the weld. In addition to above if any destructive testing is found necessary shall also be performed.

8.20 PILE HEAD TREATMENT

The single ply plasticized PVC membrane is dressed up to the outer surface of the pile head or anchor or up stand. The membrane is then encapsulated in with a high strength flowable epoxy mortar having a minimum thickness of 10mm below the membrane and mini 20mm on top of it and extended to the edge of outer surface of the interface. The key properties of the high strength flow able epoxy mortar shall be as mentioned in the following table.

PROPERTY	**TEST METHOD**	**UNIT**	**ACCEPTANCE VALUE**
Solids Content	DIN 53213	%	100
Tensile Strength	BS 6319, Part 7	MPa	11
Compressive Strength	BS 6319, Part 2	MPa	100
Flexural Strength	BS 6319, Part 3	MPa	25

8.21 QUALITY ASSURANCE & SUPERVISION

A detailed work procedure and inspection and test plan (ITP) in line with this specification and manufacturer’s specification with resources deployment shall be

prepared by the contractor and submitted to NPCIL for approval before proceeding with the work. Contractor shall carry out testing of materials as per direction of Engineer and shall submit testing reports and manufacturer's test certificates to the Engineer. A strict check on membrane properties and installation shall be exercised by Contractor's QA Engineer and necessary records in this regard shall be submitted to NPCIL. Contractor shall provide necessary assistance to NPCIL in supervision of water proofing work.

During the entire process of work under this specification, the Contractor shall arrange at his own cost the supervision of the work on water proofing by the manufacturer's/ specialized agency's representative to ensure that the work is being executed as per manufacturer's specifications and instructions.

8.22 GUARANTEE

The Contractor shall make periodical inspection and repair the waterproofing for any apparent defects to ensure complete waterproofing during the guarantee period. The Contractor shall submit a bank guarantee from a scheduled commercial bank (other than co-operative bank) for an amount of 10% of the cost of water proofing works carried out. The bank Guarantee shall be valid for a period of ten (10) years from the date of acceptance of the water proofing work by NPCIL.

9. DELETED

10. REINFORCEMENT

10.0 SCOPE

The work covered under this section shall include supplying, cleaning, cutting, bending, placing, binding and securing of reinforcement in position for all structures. For use of Fusion Bonded Epoxy Coated bars the relevant specification shall be followed.

10.1 STANDARDS AND SPECIFICATIONS

The provisions of the latest revisions with amendments, if any, of the following Indian Standards and other relevant codes shall form part of this specification to the extent they are relevant. Where the provisions of these Standards/Codes are in conflict with the stipulations of this specification, the specification supersedes the respective Standard or Codes.

10.1.1 BUREAU OF INDIAN STANDARDS

IS – 1786	High strength deformed steel bars and wire for concrete reinforcement-Specification.
IS – 456	Plain and reinforced concrete – code of practice
IS – 2502	Code of practice for bending and fixing of bars for concrete reinforcement.

IS – 9417	Welding cold worked steel bars for reinforced concrete construction – recommendation for welding.
IS – 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS – 822	Code of procedure for inspection of welds.

10.1.2 OTHER STANDARDS

1. ASME Section III DIVISION
2. Qualification of splicing system

10.2 MATERIAL

Material covered under this specification is a high yield strength deformed bar (HYSD) and TMT bars of grade Fe 500 conforming to IS: 1786, as specified in the drawing. For Fe 500 grade steel, the total elongation shall be more than 14.5 % and the ultimate tensile strength of the bar shall be 15 % more than the specified 0.2 % proof stress/ yield stress. This requirement is over and above the requirements specified in IS 1786. The Contractor shall submit the manufacturers test certificate for the material. Random tests i.e. minimum 1 sample per 150MT or at least one sample from each heat, for each diameter of bar shall be performed as required by the Engineer in his presence. All costs, incidentals to such tests shall be borne by the Contractor and shall be deemed to have been included in his quoted rates. Steel not conforming to the specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scales, loose rust, dust, bituminous material or any other substance that will destroy/ reduce bond. All bars shall be thoroughly cleaned before fabrication and placement. Pitted and defective bars shall not be used.

The steel shall be supplied by main manufacturers like SAIL, TATA Steel & RINL etc., who manufacture the rebars using billet produced from ore itself and not by rerolling of steel.

10.3 STORAGE

10.3.1 The reinforcement steel shall not be kept in direct contact with ground but stacked on top of an arrangement of concrete pedestal or timber sleepers. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deteriorations.

10.3.2 It shall be stored under cover, as desired by the Engineer without any extra cost. If necessary, the reinforcement steel, other than Fusion Bonded Epoxy Coated bars, shall be coated with cement wash before stacking, to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage. Any reinforcement, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for the work.

10.4 FABRICATION

10.4.1 The reinforcement bars shall be straightened, cut to size using cutting machine & shall be cold bent using bar bending machine, without the use of heat, to the shapes mentioned in the Drawings, as per relevant Indian Standards. Bars having cracks or splits on the bends shall be rejected. The bar bending schedules shall be prepared by the contractor in general (except for critical structure as decided by the Engineer) according to the reinforcement drawings and shall get it approved by the Engineer. In any case, the details given in the drawings shall be final. The high strength deformed steel bars/ TMT Bars shall not be re-bent or straightened without the approval of the Engineer. Crossing bars shall not be tack welded. Bars shall be properly tagged for easy identifications.

10.4.2 Where reinforcement bars are bent aside at construction joints and afterwards bend back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 6 times the dia for HYSD TMT bars.

10.5 FIXING / PLACING

10.5.1 Rough handling, shock loading (prior to embedment) and the dropping of reinforcement from a height shall be avoided. Reinforcement shall be accurately placed and fixed by any approved means to maintain the correct position of bars as shown on the drawings for this purpose. The contractor shall use cover blocks, spacers and chairs as per IS: 2502 to prevent displacement during placing & compaction of concrete. Concrete cover blocks as directed by the Engineer shall be used for providing specified cover to the rebars. Bars intended to be in contact at crossing joints shall be securely bound together at all such points with 1.6 mm dia soft annealed Iron wire (Binding wire). The vertical and horizontal distance required between successive layers of bars in beams, walls or similar members shall be maintained by the provisions of spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bar. The dia. of such spacer bar shall not be less than the dia. of the main bar. No reinforcement shall be bent when in position in the work, without the approval of the Engineer. In-situ bending of embedded bars using oxy-acetylene flame shall not be done. However, if it can be proved that cold bending is not possible the same may allowed at the discretion of the Engineer by taking due precautions. Erected and secured reinforcement shall be inspected and approved by Engineer prior to placement of concrete.

10.5.2 When reinforcement of the specified diameter is not available, Contractor may be allowed to replace with diameter higher than originally specified in the drawing on written approval of the Engineer at no extra cost to NPCIL. However, this option shall be used under exigency situations only and not as a general practice.

10.5.3 Exposed ends of dowel bars for underground structures shall be protected if necessary, by encasing the same in lean concrete, at no extra cost. Bars for the portion of structures above ground shall be given adequate coat of cement wash and if additional protection is needed as per the Engineer, shall be wrapped with plastic tape at no extra cost.

10.5.4 Wherever necessary/ as directed by the Engineer, before placing the reinforcement in the congested areas full-scale mock-ups shall be carried out and approval from Engineer shall be obtained. Such Mock-ups will be paid as per relevant items of BOQ.

10.5.5 For supporting the horizontal bars at height, supports drawings shall be prepared by the Contractor & shall be approved by the Engineer. Reinforcement chairs, spacers & support embedded in concrete as mentioned in the drawing or specified by the Engineer will be measured & paid separately.

10.6 TOLERANCE ON PLACING OF REINFORCEMENT

Unless otherwise specified in the drawings, reinforcement shall be placed in accordance with IS: 456.

10.7 LAP SPLICING OF REINFORCEMENT BARS

Lapping of reinforcement bars shall be done at locations shown in the drawings or as directed by the Engineer. The lap length shall not be less than that specified in the drawings and unless otherwise specified, the lap length shall be as per IS: 456. At locations where lap splice gives rise to congestion of reinforcement, such splice shall be replaced with welding/ mechanical splicing. For mechanical splicing of bar the relevant specification of mechanical splices (Threaded Coupler) shall be followed.

10.8 WELDING

10.8.1 Generally bars joints are to be made using mechanical splicing using threaded couplers or lapping. In exceptional cases only joints shall be made by welding or any equivalent splicing system like CADWELD etc. The splicing system shall be qualified as per ASME Section III DIVISION 2.

10.8.2 Field welding of reinforcement will not be permitted, without the written permission of the Engineer. Such approval will require identification of the type of steel used. Where welding is permitted, detailed welding procedure shall be submitted to the Engineer for approval. Welding of reinforcement to structural steel if required shall be done as per standard practice. Welding of reinforcement if required will be paid for as per relevant item of schedule. Welding of High Strength Cold Twisted deformed bars/TMT bars conforming to IS 1786 shall be made in accordance with the relevant Indian Standards (IS 9417).

10.8.3 The material shall be examined and compared with the manufacturer's test certificates, ISI certification marks and inspection stamps. Special attention shall be paid to the chemical composition of the material and its general weldability to meet the required standards for strength. The material shall be examined for surface defects, rust and corrosion products, presence of contaminants and any other factors, which may hamper the production of a satisfactory weld.

10.8.4 The qualifying tests for welders engaged in arc welding shall be in accordance with IS:

2751.

10.8.5 The Procedure to be adopted for the welding shall be arc welding with double V butt joints. Oxy-acetylene welding is not permissible.

In addition to the requirements specified in IS 9417, the requirements given below shall also be followed:

10.8.6 All welding operations shall be controlled to prevent a supply of more heat to the steel at a time than can be dissipated by the steel owing to its high thermal conductivity without adversely affecting the strength of the welded bars. The non-twisted portion of the deformed bar at weld junctions (25 to 50 mm) must always be cut off. Scraping of rust at joint- surfaces prior to welding is essential.

10.8.7 For edge preparation, the bar ends to be welded should be shaped by power shears and grinders. If oxyacetylene torches are used for shaping the edges (chisel edge) last 2-3 mm of the cut faces shall be removed by grinding. The amount to be ground off may be determined by tests, but should not be less than 2 mm. To avoid crookedness in bars after welding, their axes should be properly aligned prior to the welding operation. During the welding procedure, the bar may be supported to about 1 m. on each side of the joint over steel channels 2 m. to 3 m. long. Removal of slag after each alternate welding run is to be effected by brushing. The electrode shall never be lighted from the hot bar, to avoid notch effect.

10.8.8 Fusion faces and surfaces adjacent to the joint for a distance of at least 50 mm on either side shall be absolutely free from grease, loose scales, moisture or any other substance which may interfere with welding or adversely affect the quality of the weld.

10.8.9 Each layer of the multiple layer weld may be moderately peened with light blows from a blunt tool. Care must be taken to prevent scaling or flaking of weld.

10.8.10 Welded junctions of all reinforcing bars may be carried out at same section provided there are no bends, curved parts in reinforcement bars, or zones where variable loads predominate. It is recommended that all welds be located at least 50 dia away from bends.

10.8.11 Assessment after welding shall first be done to ascertain the correctness of the whole weldment by visual and dimensional inspection.

10.8.12 Mechanical testing in the form of tensile tests and 180-degree bend tests shall be carried out on prototype or sample welds. The choice of the samples will depend entirely on the Engineer, and will be made at random. Specimens for tension tests are to be chosen 1 out of every 100 joints prepared. The bend tests are to be conducted on 2 prototype specimens in 2 perpendicular directions, for every 200 joints. The specimen shall be bent by 180 degree for qualification.

10.8.13 The welded joint should be capable of resisting 90% of the actual bar strength and should not fail to develop at least 100% of the specified ultimate strength of the variety

of steel under use. The failure shall not occur at the joint location.

Weldments incapable of developing full strength shall not be used as reinforcement.

Apart from tensile testing of weldments, liquid penetrate flaw detection test as recommended in IS: 822 shall also be made on 10% of total joints on root & final pass.

10.9 FUSION BONDED EPOXY COATING BARS

10.9.1 SCOPE

These specifications cover coating of reinforcement bars with fusion bonded epoxy coating (FBEC) to be provided as corrosion protection measure, in construction of Nuclear Power plant. This coating shall be used, wherever specified so in the drawings.

10.9.2 REINFORCING BARS

The reinforcing bars to be provided with Fusion Bonded Epoxy Coating shall conform to I.S. 1786. In spite of producing test certificates by contractor for the proper quality of reinforcing bars, the quality of steel should also be tested by the FBE coating agency for bend test before undertaking coating and that if the reinforcing bar fails in bend test, it shall be rejected.

Reinforcing bars to be coated shall be fresh from rolling mills as far as possible. If the bars are rusted in quality before providing FBEC, the same shall be rejected.

10.9.3 Coating on Bars with FBEC

10.9.3.1 SURFACE PREPARATION

The surface of the steel bars to be coated shall be cleaned using shot blasting near to white metal .The surface profile shall be free from mill scale, rust and foreign matter.

10.9.3.2 The Coating shall be applied to the cleaned surface as soon as possible after cleaning. In no case the coating be delayed beyond 8 hours after cleaning.

10.9.3.3 The FBEC coating shall be done confirming to I.S. 13620 as well ASTM A775/775M.

10.9.3.4 The Fusion Bonded Epoxy Coating shall be carried out by an authorized FBE coating agency approved by Engineer.

10.9.3.5 Patch-up materials shall be procured in sealed containers with certificates from coating agency for supply of such patch-up material.

10.9.3.6 The Quoted rate for FBE coated bars shall include the use of PVC coated GI wire (Binding Wires) of 1.6 mm dia.

10.9.4 Tests for FBE Coating on Reinforcing Bars

10.9.4.1 The contractor shall produce certificate from the FBE coating agency that the quality of powder epoxy material and other components of FBEC conform to I.S. 13620 as well ASTM A775/775M. Such certificates shall accompany each delivery challan of coated bars. The Engineer may carry out such tests at plant to confirm use of proper quality of coating material.

10.9.4.2 The Coated reinforcement bars shall be tested for following properties at a specified frequency. Following tests on coated bars shall be as per I.S. 13620 at the specified frequency on routine basis and Test reports shall be jointly signed by authorized representatives of contractor and the coating agency:

Thickness of coating: One full-length bar for every twenty bars for each size of bars

Continuity of coating: One full-length bar for every twenty bars for each size of bars

Adhesion of coating: As per following frequency based on dia of bar
- Upto 16 mm dia: - 1 for every 1 tons
- Above 16mm and upto 25mm dia: - 1 for every 2 tons
- Above 25 dia: - 1 for every 4 tons

10.9.4.3 Inspite of conducting above tests and test certificates produced by the contractor and coating agency, Engineer reserves the right to carry out independent tests at coating plant for cross checking. The contractor's agreement with coating agency shall include the provision for Engineer's cross checking and that if the coating quality is not approved by the Engineer, the decision of the Engineer to reject or repair the coating shall be final and binding on all parties.

10.9.4.4 Thickness of Fusion Bonded Epoxy Coating shall be 250 (+/- 50) microns.

10.9.4.5 Holidays in coating shall not be more than two holidays per linear foot (six holidays per meter) of coated bar. All the damaged coating incurred during handling & fabrication, to the point of shipment to the job site shall be repaired. Damaged coating on a bar is permitted to be repaired if the amount of damaged coating does not exceed 1 % of the total surface area in each 0.3 m length of bar. The limit on the amount of repairable damaged coating does not include sheared & cut ends of the bars that are required to be coated with patching material. Repaired areas of damaged coating shall have a minimum coating thickness of 250 microns.

10.9.4.6 The Coating shall also meet all other requirements specified in IS 13612 as well ASTM A775/775M.

10.9.5 Handling

10.9.5.1 The coated bars shall be carefully handled in order not to drop them, not to rub them on hard surface or against another coated bar while conveying, stacking, placing or

stacking of fabricated bars. For this purpose, wooden packing batons shall be used at spacing of not more than 60 cms.

10.9.5.2 The Coated bars shall be tied to make bundles with PVC binding material to avoid damages to coating.

10.9.5.3 The cut ends of bars shall be touched up with special touch up material of the same specifications as provided by coating agency. There shall be minimum time gap to repair the cut ends and damaged portions with touch up materials and that failure to do so may cause complete rejection of the coated bars. The cut ends and damaged portions shall be touched up with repair patch-up material within four hours time gap. All damages to coating in handling etc. shall be repaired irrespective of their size. This stipulation supersedes provision of clause 13 of IS 13620.

10.9.5.4 The Contractor will be paid for the same quantity of reinforcement bars used in the work and paid under relevant item.

10.9.5.5 While bending the bars, the pins of workbenches shall be provided with PVC or plastic sleeves. It is preferable that contractor install bar bending machines suitable for FBE coated bars and that each bending operation is done in a time of not less than 90 secs.

10.9.5.6 The coated steel shall not be directly exposed to sun rays and rains and shall be protected with opaque polythene sheets or such other approved materials.

10.9.5.7 While Doing concreting, the workmen or trolleys shall not directly move on coated bars, wooden planks shall be placed on the bars for movement of workman & trolley of material, by the contractor.

10.9.5.8 In spite of all test certificates, if the coated bars are roughly handled by the contractor either during transport, fabrication, stacking, placing and concreting etc. or handled in such a manner as to damage the coating for area or portion more than reasonable, the Engineer reserve the right to reject the FBE coated bars and such rejected bars shall be removed by contractor from work site within three days. The decision of Engineer will be final as to reject the bars with damage coating or to allow repairing the coating, or to get it recoated entirely at the contractor’s cost.

10.9.6 STORAGE

10.9.6.1 The Bars shall be stored as close as possible to the area of the structure where they will be placed (fixed) to keep handling operations to a minimum. Deliveries of the coated bars to the job site should be well coordinated to avoid any long term storage at site when stored in open. If circumstances or other conditions make it necessary to store FBE coated bars outdoors for an extended period of time, the coated bars should be protected from sunlight & salt spray, and sheltered from the weather.

10.9.6.2 FBE coated bars shall be stored above ground on protective timbers, supports shall be provided at regular interval to avoid sagging of the bundle. Such wooden or padded contact shall be at spacing of not more than 60 cms.

10.9.6.3 If a relatively large quantity of FBE coated bars is to be stored in a small area, bundles of straight bars shall be stacked with adequate blocking between the layers of bundles.

10.9.6.4 FBE bars shall be covered with opaque polythene sheets or other suitable protective material. The protective cover shall be draped over the sides of the bundles around the perimeter of the stack. The cover shall be properly secured with provision of air circulation to minimize the condensation under the covering.

11. REINFORCEMENT, SPLICING AND MECHANICAL FASTENERS & MECHANICAL COUPLERS

11.0 SCOPE

These specifications cover threaded couplers to be used for joining reinforcement bars, in lieu of laps/welding/mechanical splicing.

11.1 GENERAL

The couplers shall be of standard parallel square thread type. Ends of the reinforcement bars, which are to be joined, shall be enlarged by cold forging, threaded in such a way that thread diameter is not lesser than the parent bar to be joined. The material of the coupler shall be of same quality or of superior quality than the quality of material of the parent bars (i.e. reinforcement bars to be joined). The joint shall have guaranteed bar break i.e. when the joint is tested in universal tensile testing machine, the bar shall fail away from the coupler i.e. not within the coupler as well as within 2 times the diameter of bar from the ends of the coupler, which can be considered as affected zone. The Guaranteed Bar break condition is not mandatory, if the failure load of coupled specimen is higher than 1.15 times of its minimum specified yield stress. The coupler shall be qualified as per ASME, Section III, and Div.2. Additionally it shall meet all the requirements of "Class H" type coupler as specified in IS 16172. The safety margin in coupler design shall be such that guaranteed bar break is ensured even if 15% of the total threads length are out of coupler during installation.

The hand tightening of coupler shall be sufficient in the field and no mechanical means shall be essential for tightening. During testing, the coupler should only be hand tightened.

The process of manufacturing of the coupler, cold forging and threading including testing shall be carried out as per ASME approved quality assurance programme. The manufacturer of coupler shall hold a valid Quality System Certificate (QSC) from ASME. Installation of the coupler and supervision shall be done by the qualified personnel.

11.2 MANUFACTURING OF COUPLERS

All the couplers shall undergo quality checks on uniformity of threads, dimensional accuracy etc. Each coupler shall be clearly stamped indicating batch number, heat

number and diameter. This number shall be traceable to the original cast. The relevant material mill certificate shall be submitted with supply of a particular lot. The certificate shall give salient material properties.

11.3 THREADING OF ENDS OF THE REINFORCING BARS

This threading activity shall preferably be done at site. The various stages involved in threading are as given below

i. CUTTING

The ends of reinforcement bars shall be cut by mechanical means to get a perfect plain end surface, perpendicular to the axis of the bar.

ii. COLD FORGING & THREADING

After cutting, the ends of the bar shall be enlarged by cold forging such that the area of cross section after threading shall not be less than the area of cross section of the parent bar. The length of cold forging shall be adequate for proposed thread length as per manufacturer's design. Threading shall be done, preferably on lathe machine. The threads shall be square parallel type, to suit the couplers. The thread length and depth shall be as per manufacturer's design. After threading is completed, the threaded length of the bars shall be protected by providing plastic caps, before taking the bars out of the shop.

iii. QUALITY CONTROL IN MAKING OF THREADS

The work in shop shall be fully supervised by the Manufacturer representative. Double forging of bars is not permitted. In case of improper cold forging, the forged end of the bar shall be square cut and fresh cold forging shall be undertaken. The threading shall be checked with 'go' and 'no go' gauges.

For threaded coupler systems, every prepared bar end shall undergo a load test prior to actual use. The minimum test loading shall be equivalent to 80% of specified yield strength of bar. For this purpose contractor shall deploy the machine having facility of integrated load testing. The "Integrated" means that the testing operation is performed automatically by the same machine used to prepare the bar ends. A positive indication shall be punched on the rebar to indicate that this operation has been carried out and bar end has qualified for specified strength.

11.4 INSTALLATION OF COUPLERS IN THE FIELD

The installation of couplers in the field, for joining reinforcing bars, shall be undertaken by trained manpower and as per manufacturer's instructions. Threads of both the couplers and the bars shall be thoroughly cleaned with acetone or any other solvent, just before installation.

Where couplers are cast-in the concrete, but connection is not to be completed

immediately, the couplers shall be internally greased and plastic capped to a protection detail acceptable to the engineer. This cap shall be removed only when next bar is to be attached & then cleaned before joining the next bar.

11.4.1 The contractor shall arrange for a suitably qualified manufacturer's representative, experienced in mechanically connecting reinforcement, to be present at site before the start of work for initial training of personnel, and also to demonstrate the equipment and techniques as necessary.

11.4.2 The contractor shall submit to the Engineer, for his acceptance, a method statement for mechanically connecting the reinforcement and for the installation and verification in the field. This shall take into account any special requirements for horizontal, vertical and inclined couplers and shall include a rectification procedure, if the connection is incorrectly made. It shall also cover the correct methodology for handling of tools and equipment for mechanical connection on site. The following information shall also be included:

(a) requirements for cleanliness
(b) equipment for threading bars
(c) method of locking the connections on both rebars
(d) method of verification of final rebar alignment and coupler integrity.

11.4.3 Each coupler shall be visually examined prior to use to ensure the absence of rust and of any foreign material on the inside surface. All completed couplers shall be inspected and verified in accordance with the approved QAP. The Contractor shall ensure the acceptance of the Engineer for a procedure for documenting the inspection of the couplers. The contractor shall retain inspection records and shall submit copies to the engineer within 7 days. The Couplers that do not meet the acceptance standards shall be completely removed and the bars re-connected, as required.

11.5 QUALIFICATION TESTS

The splices shall be qualified as per ASME Section III Div-2, IS 16172 and by conducting following tests:

11.5.1 STATIC TENSILE TEST

Mechanical connections shall be tested in all reinforcing rebar sizes. All rebar transition connectors shall also be tested. For each rebar size, a minimum of six connections in each load direction shall be tested in accordance with ASTM A 370. A tensile test on an unspliced specimen from the same bar used for the spliced specimens shall be performed to establish actual tensile strength.

- The average tensile strength of the splices shall not be less than the followings:

a) 90% of the actual tensile strength of the reinforcing bar being tested.
b) 100% of the specified minimum tensile strength

- The tensile strength of an individual splice system shall not be less than the 115% of the specified minimum yield strength of the spliced bar.

11.5.2 CYCLIC TENSILE AND COMPRESSIVE TEST

Cyclic tensile and compressive test: Mechanical connections shall be tested in all reinforcing rebar sizes. For each rebar size, a minimum of three connections shall be tested for low cyclic tensile test. Each specimen shall withstand 100 cycles of stress variation from 5% to 90% of the specified minimum yield strength of the reinforcing bar. One cycle is defined as an increase from the lower load to the higher load & return. The test shall be performed as per Annexure D of IS 16172.

11.5.3 PERCENTAGE ELONGATION

The minimum uniform elongation (Elongation at maximum force) in the reinforcement bar outside the length of mechanical splice as measured as per Annexure B of IS 16172 shall be 3 % before failure of test piece.

11.5.4 SLIP TEST

The total slip value when measured in accordance to test procedure described in Annexure C of IS 16172 shall not exceed 0.10 mm.

11.5.5 TEST FOR AVOIDANCE OF STAGERRING

The strain measured over the full length of the splice at 90% of the specified minimum yield strength of the bar shall not exceed that of a bar that is not mechanically-spliced by more than 50%. The test shall be performed for all diameter of couplers.

11.5.6 LOW CYCLE FATIGUE TEST

The mechanical splice shall withstand 10000 cycles of alternating tension & compression load, when tested as per Annexure E of IS 16172.

11.5.7 HIGH CYCLE FATIGUE TEST

The mechanical splice when tested accordance to Annexure E of IS 16172 shall withstand 2 million cycles (2000000 Nos)of varying axial tensile load with a stress range of 60 MPa with upper stress in the test equal to 0.6fy.

11.5.8 PRODUCTION TESTS & ACCEPTANCE CRITERIA FOR A LOT

Static Tensile tests, as per ASTM A370, shall be conducted on each bar size & grade

for each lot as follows. The criteria mentioned below are in variance with the above referred codes.

Sr No	No of Coupler in the Lot	No of sample to be tested	Acceptable Defective couplers
1	Upto 500	14	NIL
2	501-1200	20	NIL
3	1201-3200	32	1
4	3201-10000	50	2
5	10001 and above	50+ 2 for each 1000 Nos beyond 10000	Not more than 4% of the samples tested

The lot is defined as the group of couplers which are of same size, type, class, material traceable to same cast and manufactured under similar conditions of production. All the tests shall ensure guaranteed bar break at a load not lower than the specified tensile strength of the bar. The quoted rate shall be inclusive of carrying out above tests and no separate payment shall be made for these tests.

11.5.9 The Contractor shall submit to the engineer for acceptance a report on these Proving Tests, within seven working days of the tests. The report shall provide full details including:

(a) Results of all tests
(b) Details of dimensions, geometry.
(c) Details of test procedures
(d) Description of test rig/load cell
(e) Description of load monitoring, strain measurements
(f) Calibration certificates.

11.5.10 From each test on the coupler and control bar specimens, the following information shall be provided:

(a) Stress-Strain (or Load Displacement) curves
(b) Yield Load & Yield Strength
(c) Elongation of the mechanical connection
(d) Ultimate load & Ultimate Tensile Strength
(e) Mode of failure
(f) Gauge length used for strain measurement and statement of how gauge length was determined.

12 PILING WORKS

12.0 SCOPE

This specification covers the works involved for bored cast in situ reinforced cement concrete (RCC) piles including all specific requirements for installation/casting of pile, testing (initial, routine and other NDT) and analysis of the various test results to assess

their vertical, horizontal and pull out load carrying capacities, confirm pile integrity, apportion skin friction and end bearing capacity of the pile and arrive at dynamic properties of soil-pile system. *All the piles within the scope of this tender needs be toe grouted. The procedure for Toe grouting shall be finalized by the contractor in consultation with Engineer.*

12.1 CODES, STANDARDS & SPECIFICATION

12.1.1 Latest Indian Standards on Piles

IS 2911 : Part 1: Sec 2 Code of practice for design and construction of pile Foundations: Part 1 Concrete piles, Section 2 Bored cast-in-situ piles
IS 2911 : Part 4: Load test on piles
IS 5121 : Safety code for piling and other deep foundations
IS 9716 : Guide for lateral dynamic load test on piles
IS 14362 : Pile boring equipment - General requirements
IS 14893 : Non Destructive integrity testing of piles-Guidelines

12.1.2 Latest ASTM

ASTM D 4945: Standard Method of test for High Strain Dynamic Testing of Piles
ASTM 6760: Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Cross-hole Testing
ASTM D 5882: Standard Test Method for Low Strain Integrity Testing of Piles

Reference to any code shall always mean reference to the latest revised edition of the code including all its amendments up to date, unless otherwise specified. In the event of any conflict between the requirements of this specification and those of the referred codes, the former shall govern.

12.2 DESCRIPTION

12.2.1 GENERAL

Specifications to be followed for providing RCC bored cast in situ piles wherever required as per design . The scope in general consists of constructing the RCC bored cast in situ pile foundation .

The testing of piles shall be carried out by the contractor in line with relevant BIS codes, and / or ASTM codes, as specified above and procedures to be developed by the contractor/Vendor and approved by NPCIL. Initial and Routine (static and dynamic) tests shall be carried out on test piles and working piles, respectively as per provisions of BIS/ASTM and as approved by NPCIL.

The work involves but is not limited to the following:

1. Construction of Pile foundation .

2. Conducting Initial, Routine Load tests (Static and dynamic) on designated Test / working piles namely Vertical, Lateral, Pull out and Dynamic load tests.
3. Conducting Non-Destructive Testing (NDT) to assess pile integrity.
4. Toe grouting of pile

The contractor shall submit the work procedures for different items of piling works in line with IS/ASTM, Technical Specification herein under and get it approved from Engineer.

Upon completion of the piling work, all casing equipments, construction tools, protective covering and debris resulting from the piling operations shall be removed from the works site with the permission of the NPCIL.

12.2.2 MINIMUM REQUIREMENT OF PILING EQUIPMENT

The equipment & accessories should be compatible with the type of sub-soil, method of construction, type of founding strata & required penetration in the founding strata. The capacity of rig shall be adequate so as to bore up to required depth with specified diameter. Rig shall be equipped with suitable chisel to penetrate through any local obstruction/ hard strata.

Hydraulic self-propelled rotary piling rigs complete with adequate torque capacity and crowd value shall be deployed to complete the entire job as per the time schedule and specifications provided in this tender document. The Contractor shall mobilize adequate spares; cutting tools (e.g. flat teeth bits, round shank bits, holders, etc.) to avoid any stoppage of work.

The Contractor shall provide all the equipment, tools and plants required for the work.

12.2.3 SURVEYING AND LAYOUT

It is the sole responsibility of the contractor to bring to site all surveying instruments necessary for the marking out, fixation of levels, etc. and conduct these survey operations with utmost accuracy. The contractor shall put-up stable bench marks etc. as necessary for the work. NPCIL will provide benchmark location and elevation with respect to plant grid. The contractor shall be entirely responsible for accurate setting out of the work and he shall at his own expense make good any defects arising from errors in line and levels.

12.2.4 BORING

The boring shall be done as per specific requirements of soil strata and the procedure / methodology shall be approved by Engineer-In-Charge.

The Contractor, while boring the pile bores, shall constantly collect the bore spoils and these shall be compared with the layer wise soil classifications reported in the bore-log details of the location, reported in the soil investigation report. Should there be any variation between the two soil classifications, these shall be immediately reported to

the Engineer. Rig register and weekly report as per the format, approved by NPCIL shall be submitted to Engineer-In-charge of the project.

12.2.5 CLEANING OF PILE BORE

After completion the pile bore up to the required depth, the bottom of the pile bore shall be thoroughly cleaned. Cleaning shall ensure that the pile bore is completely free from sludge/bored material etc. Necessary checks shall be made to confirm the thorough cleaning of the pile bore as per the recommendations of IS 2911-Part1- section 2.

Pile bore spoil shall be disposed of from site within 1 Km. away as directed by the Engineer.

12.2.6 DEWATERING

The dewatering for the area will have to be carried out by the contractor at his own cost.

12.2.7 INFORMATION TO BE SUBMITTED AS PART OF THE TECHNICAL BID

If piles are envisaged in the structure, bidder shall submit the following information along-with the bid:

1. Number of the piling rigs proposed to be deployed.
2. Full Technical details of piling rigs and accessories in the form of catalogues, data sheets, etc.
3. Piling procedure, piling program and accessories to be mobilized by the contractor.
4. Complete Construction Methodology. However, work procedures and quality assurance plan (QAP) for the work will be required before start of the work. The contractor shall use only Ready mixed concrete from the batching plant for the proposed piling works.
5. All data sheets, rig register, test reports, Soil/Rock profile data.
6. Details of toe grouting to be done for all piles.

12.3 REQUIREMENTS

All work shall be carried out in accordance with this specification and contractor shall ensure meeting of all the requirements as laid down hereunder:

The work shall include supplying and providing necessary materials, mobilization / demobilization & operation of all necessary equipment, consumables providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labor etc. as required to carry out the complete piling work, and submission of records & reports as per schedule.

The Contractor shall confirm the "Safe Load" capacities by conducting both initial and routine load test on piles.

It is essential that all equipment and instruments are properly calibrated at the commencement of test so that they represent true values. The instruments shall be re-calibrated at the frequency as per manufacturer's specification. Certificates to this effect from an approved institution/National Accreditation Board for Testing and Calibration Laboratories (NABL) shall be furnished to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.

Each pile shall be identified with a reference number. Sequence of piling shall be such that there is no damage caused to the concrete recently laid in the adjacent pile and as per approved drawings. Construction of piles shall be done in accordance with the priority of construction of various buildings. The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed pile. Sequence of piling shall be approved by the Engineer.

12.3.1 TERMINATION OF PILES

The casting of piles shall start from levels strictly as per approved construction drawings. In no case casting of piles should start from levels higher than those indicated in the approved drawings. The top of the pile shall be cast above the cutoff level so as to permit removal of all laitance and weak concrete before embedment into raft. The pile top shall be terminated at minimum 600mm above Pile cutoff level. The same will be chipped off up to cutoff level before the commencement of pile-raft construction to progress the job further.

12.3.2 SAFE LOAD CARRYING CAPACITY

The contractor shall conduct the tests as specified in the drawing or as per the direction of Engineer and determine the minimum safe load for the piles constructed for Vertical Compression/Lateral/Uplift.

12.4 MATERIALS

Materials shall conform to specifications for materials included in the specification of 'normal concrete', 'reinforcement' and 'coupler' in this tender document.

12.4.1 CONCRETE

The concrete shall be of M35 grade or as specified in the approved drawings. The minimum cement content shall be 350 kg/m^3 (including fly ash as defined in technical specifications for plain and reinforced cement concrete) and allowable slump shall be between 150mm to 180mm as specified in IS 2911 Part 1/Sec 2. The tests on concrete for piles shall be tested as per the relevant specification given in this tender. Suitable cylindrical cover blocks with center hole shall be used to maintain the specified cover

as per the approved drawings. The re-steel ties used for holding cover blocks for re-steel.

12.4.2 REINFORCEMENT & COUPLERS

Reinforcement & couplers shall conform to relevant technical specifications given in this tender.

12.4.3 STABILISING MUD/BENTONITE/POLYMER

The drilling mud for stabilizing the borehole in bored piling work should have properties and quality control conforming to the requirements of IS 2911-(Part1-Sec-2). In case polymer is used, the specification and methodology for its use shall have prior approval from NPCIL.

The bentonite / polymer slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through setting tanks of adequate size to remove the sand and spoils from the slurry before the slurry is re-circulated back to the boring. The bentonite slurry mixing and re-circulation plant shall be suitably designed and installed. The bentonite slurry shall be maintained at 1.5 m above the ground water level during boring operations and till the pile is concreted. When DMC (Direct mud circulation) or RMC (Reverse mud circulation) method is used the bentonite slurry shall be under constant circulation till start of concreting.

For tremie concreted piles, a sample of drilling fluid shall be taken from the base of the borehole by means of an approved sampling device in the first few piles and at a suitable interval of piles thereafter. The concreting operations shall not be taken up when the fluid density is more than 1.25g/ml.

After completion of piling work, area around piles shall be restored with compacted soil-cement mix after removal of bentonite slurry /muck, at no extra cost to NPCIL.

12.5 CONSTRUCTION

12.5.1 Construction of piles shall be carried out only after excavating ground up to the desired founding levels/levels as per requirement of ground improvement technique to be adopted and as per the approved drawings.

12.5.2 Pile shall be constructed by using temporary casing up to required depth as per site conditions. This is to ensure not only the stability of side soil and also to ensure good quality concrete in the entire length of pile. Adequate bentonite mud / polymer or any other suitable material (if required) may be used during the boring below temporary casing. The contractor shall ensure the stability of bore by adopting suitable combination of temporary casing pipe and bentonite/ polymer slurry for stabilization.

12.5.3 Immediately before placing of reinforcement and concreting, the bored hole shall be cleaned of all the loose material and debris. The pile tip zone shall be thoroughly cleaned by flushing the bore with fresh bentonite slurry/polymer to completely replace

the old bentonite slurry / polymer used during the previous operations. This shall be carried out for about 45 minutes in two stages. Cleaning for about first 30 minutes shall be done before lowering of reinforcement cage & cleaning of about second 15 minutes after lowering the reinforcement cage.

12.5.4 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pile bore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth and clean the pile bore.

12.5.5 The soil profile and design requirements shall dictate length of temporary casing pipe for construction purposes and shall be withdrawn during casting of the pile. The temporary guide casing shall be withdrawn cautiously, after concreting is done up to the required level. While withdrawing the casing concrete shall not be disturbed.

12.5.6 Cut-off level of the piles shall correspond to those given in the approved drawings. To ensure dense and sound concrete up to cut-off level, concreting shall extend minimum 600 mm above cut-off level. The vertical reinforcement shall project above the cut-off level as per the approved drawings.

12.5.7 In case the reinforcement cage is made up of more than one segment, the same shall be assembled by threaded couplers before lowering. Reinforcement as required shall be made into stiff cages with stiffener rings of appropriate diameter at suitable spacing to withstand handling without any damage or distortion.

Borehole shall be thoroughly cleaned to make it free from sludge or any foreign matter before lowering of reinforcement cage. The full length of reinforcement cage should be in place before start of concreting. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable spacer blocks to ensure concentric alignment in the shaft. Care shall be taken to preserve correct cover and alignment of reinforcement and avoid damage to it throughout the complete operation of placing concrete.

12.5.8 Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by the faulty consolidation or entrapped air. Proper care shall be taken to ensure that the fluid alluvial soil does not penetrate the concrete.
Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911 (Part1-Sec2). Concrete shall be placed by means of tremie pipe, which will be suitably closed at bottom at the start of concreting. The tremie pipe must extend up to the bottom of the borehole at the start and may be withdrawn in sections as the level of concrete rises in the borehole; but its discharge end shall at all times be embedded in the concrete to a minimum depth of 2m. Placing of concrete should be continuous and the pile holes will be maintained full with the bentonite slurry where used throughout the concreting operation. Slurry displaced from the borehole by the concrete shall be channeled away or pumped into suitable mud pond for re-use or disposal to waste.

12.5.9 The record of volume of concrete poured in each of the piles shall be maintained. After concreting the actual quantity of concrete shall be compared with the average obtained from observations made in the case of a few piles already cast. If the actual quantity is found to be considerably less, the matter should be investigated and appropriate measures taken.

12.5.10 **Control of alignment**: Piles shall be constructed vertically as accurately as possible as per the construction drawing. The permissible limits for deviation with respect to position and inclination/alignment shall conform to IS-2911 (part 1/Sec2).

12.5.11 **Preparation of pile head:** Before casting the piled raft, the excess concrete shall be cut off up to pile cut-off level as shown in approved drawings. In case sound concrete is not met with at such elevation the piles shall be cut up to an elevation where sound concrete is met. Care shall be taken not to damage the reinforcement or the concrete below cut off elevation during such stripping operations. Where chipping to be done to a level lower than the specified cut off elevation to obtain dense and sound concrete, the Piling Contractor shall build up the pile up to cut off elevation at his own cost.

The exposed part of concrete above the Cut off level shall be removed/chipped off and made square at cut off level not before seven days of casting of pile. The projected reinforcement above Cut off level shall be property cleaned and bent to the required shape and level to be anchored into the pile raft as shown in the drawing.

The pile top shall be embedded into the pile cap/raft by minimum 50 mm or clean cover to reinforcement, whichever is higher.

12.6 DEFECTIVE PILES

The Engineer reserves the right to reject any pile which in his opinion is defective with reference to technical specification & construction drawing on account of load capacity, structural integrity, position, alignment, concrete quality, improper cleaning of borehole before concreting, etc. Piles that are judged defective shall be pulled out or left in place as decided by the Engineer without affecting the performance of adjacent piles. If the adjacent pile is affected, the contractor shall install additional piles to substitute the adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the EIC at no extra cost to NPCIL.

12.7 QUALITY ASSURANCE PROGRAMME

The Contractor shall submit and finalize a detailed Field Quality Assurance Program within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc., the Engineer shall identify, customer hold points, on finalized field quality plan, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as per manufacturer's instructions to give accurate testing results.

12.8 RECORDING OF DATA

Daily site records shall be maintained by the Contractor for the installation of piles against each Rig and shall contain the number and dimension of the pile, depth bored, time taken for boring and concreting. Contractor shall maintain field bore log. When drilling mud /polymer is used, amount of bentonite / polymer needed for stabilization of bore, specific gravity of the fresh supply and contaminated mud in the bore hole before concreting shall be checked and recorded regularly. Record of concrete volume actually cast per pile against required volume shall be maintained. Detail of any obstruction encountered its nature, depth and obstruction time. Any deviation from the designated location alignment or load capacity of any pile shall be noted. Typical data sheet in triplicate for facility of recording piling data to be prepared by the Contractor before starting of actual piling operation at site and information to be recorded against each pile in the data sheet shall be signed by the contractor and countersigned by NPCIL. One copy of the data sheet shall be retained by the Contractor and the other two copies to be submitted to NPCIL for records & future reference.

A full record of pile load test results shall be submitted in triplicate to the Engineer immediately on completion of each test. The record shall also include the plots of load settlement (for various stages of loads) characteristics of pile and also the interpretation of the pile load test curve as per criteria for safe loads mentioned in the specifications for testing concrete piles forming a part of this tender. Any special observations shall be duly explained by the contractor.

Contractor’s competent supervisor (geotechnical engineer) shall always be present to record the necessary information during the installation of piles. The data to be recorded shall include:

1. Pile number and location
2. Existing ground level, cut-off-level and level of top of the casting
3. Nominal shaft and inside diameter of casing
4. Data and time of setting up of rig at the pile location.
5. Data and time of start of boring.
6. Length of casing driven and depths bored vs time.
7. Description and thickness of various strata bored.
8. Details of any obstructions encountered (depth from existing ground level, thickness and time taken to penetrate through the same)
9. Chiseling depth and time.
10. Final depth of boring (founding level).
11. Standard penetration test at the bottom of the bore hole, if any.
12. Date and time of completion of boring.
13. Data and time of start and completion of flashing of the bore hole with fresh Bentonite fluid before Concreting.
14. Time of lowering Reinforcement cage and tremie pipes with total length thereof.
15. Date and time of start of concreting
16. Level of concrete inside the bore hole and tremie pipes at various stages of concreting.
17. Concrete grade, mix proportion, water cement ratio and slump test results.

18. Empty boring length and concrete length below cut-off-level.
19. Results of tests on Bentonite slurry used.

Typical data sheets of recording piling data shall be as given in Appendix-D of IS: 2911(Part I/ Sec.2).

Any deviation from the designed location, alignment or load carrying capacity of any pile shall be noted and promptly reported to the Engineer..

On completion of each pile construction, pile record in triplicate shall be submitted to Engineer-in-Charge within two days of completion of concreting of the pile.

On completion of boring and cleaning the bottom of each pile bore shall be checked by the methods as approved by the Engineer, to ensure that it is free from pile bore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of Engineer.

12.9 PILE TESTING

The contractor has to prepare work procedure for conducting the tests in line with IS/ ASTM, Technical Specification herein under and get it approved from Engineer before start of test .

Pile Load Test: Both initial and routine load tests shall be conducted for all the types of testing i.e. vertical, lateral and pull-out. The load tests shall be carried out after concrete attains full strength.

Non-destructive testing of piles: NDT of piles (Low strain integrity test, high strain dynamic testing and cross-hole sonic logging test as per ASTM codes) shall be carried out by expert team or by engaging an expert agency. The staff of the team shall have experience of carrying out these types of tests and knowledge of analyzing the data. Credentials of expert team/expert agency shall be submitted for acceptance by NPCIL.

12.9.1 PILE LOAD TEST DETAILS

12.9.1.1 General

1. For pile load tests, the test set up shall be as per relevant BIS, ASTM standards and specifications for testing of concrete piles.
2. The testing shall be done by specified method of loading in successive increments as per the relevant clauses of IS: 2911 Part 4.
3. Tests shall be carried out at the cut-off level.
4. Maximum test loads for different types of piles shall be as per the approved drawings.
5. All the piles shall be provided sonic logging tubes to carry out Cross hole Sonic Logging Test.
6. The number of tests (other Cross hole Sonic Logging Test) required shall be as approved by the engineer.
7. A method statement for all the load tests shall be submitted to NPCIL and testing shall be carried out after approval of the same.

8. The details of tests to be carried out on piles are presented below.

PILE TESTING MATRIX

Tests on Piles		
Initial Load Tests	Routine Load Tests	Non-Destructive Tests (Both Initial and Routine)
1. Vertical Load Test	1. Vertical Load Test	1. Low Strain Integrity Test
2. Lateral Load Test	2. Lateral Load Test	2. High Strain Dynamic Test
3. Uplift Load Test	3. Uplift Load Test	3. Cross Hole Sonic Logging Test

12.9.1.2 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast test piles following purposes:

1. Confirmation of estimated pile capacities at founding level.
2. To provide guidelines for setting up the limits of acceptance for routine tests.
3. To confirm suitability of piling system.
4. To have a check on calculated load by dynamic or static approaches.

The number of tests to be conducted for each mode (vertical compression, pull out and lateral) and each type of pile and maximum test load shall be as per approved drawings.

The following initial load tests shall be carried out as per IS 2911(Part 4):

1. Initial vertical load test.
2. Initial lateral load test
3. Initial pull-out load test.
4. Initial vertical cyclic test

12.9.1.3 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles as per approved drawings. Routine load tests shall be carried out for following purposes:

1. To confirm the safe load of the pile.
2. Checking safe load and extent of safety for the specific functional requirement of the pile at working load
3. Detection of any unusual performance contrary to the findings of the initial test, if carried out.

The following routine load tests shall be carried out as per IS 2911(Part 4):

1. Routine vertical load test.
2. Routine lateral load test

3. Routine pull-out load test.

For routine lateral load test the loading shall be continued till one and half times the safe lateral load or 5mm deflection, whichever occurs earlier.

12.9.2 RECORDING OF DATA AND PRESENTATION

12.9.2.1 The initial and routine pile load test data essentially concerns three variables, namely, load, displacement and time. These are to be recorded sequentially for the tests under consideration and recorded in a suitable tabular form along with the information about the pile.

12.9.2.2 The initial and routine pile load test data may be suitably presented by curves drawn between the variables and safe loads shown on the graphs. Load-displacement curve should be an essential part of presentation.

12.9.3 REPLACEMENT OF DEFECTIVE/ REJECTED PILES

During execution of pile foundation work, if the bore holes need to be abandoned due to any reason and pile position to be shifted or realigned, other than for any design requirement by the Engineer, fresh bore holes are to be executed at a suitable new position, as decided by the Engineer, which may demand for resizing of pile raft including possible increase in reinforcement quantity due to resizing of pile raft. In all such cases the abandoned bore holes are to be filled up with plain cement concrete of grade M15 so that no cavity remains in the bore hole of the abandoned pile. No extra claim whatsoever from the contractor on account of abandoned bore hole, filling up of abandoned bore hole with concrete and any extra cost due to resizing of pile raft including increase in reinforcement quantity will be accepted and same is deemed to be carried out by the contractor at his own cost.

Piles showing unsatisfactory results as per load tests shall be treated as defective piles. Piles/boring/casing that are defective shall be left in place/ pulled out as directed by Engineer without adversely affecting the performance of the adjacent piles. In case the hole from which pile is pulled out is abandoned, the same needs to be filled up with concrete of grade M 15 at no extra cost to NPCIL. No payment shall be made for extra expenditure incurred in constructing alternative piles and implementing the changes in the design of raft on account of change in location of piles.

12.10 NON DESTRUCTIVE TESTING OF PILES

12.10.1 LOW STRAIN PILE INTEGRITY TEST

12.10.1.1 GENERAL

Low strain Pile Integrity Test (PIT) is a non-destructive integrity test method to establish the Integrity of the pile along its length and to identify the deficiency in quality of pile, if any.

In PIT the impact shall be made using small hand held hammer. The evaluation of PIT records shall be conducted according to the Pulse-Echo (or Sonic Echo – a time domain analysis) analysis method.

12.10.1.2 **TEST METHOD AND REFERENCE CODE**

The test requires the impact of a small hand held hammer on the shaft top and the measurement of motion of the pile top in terms of acceleration or velocity. The input compression wave from the hammer is reflected from pile toe (or a defect) and returns to the pile top at a time related to the speed of travel of the wave in the pile material. The test shall be performed as per ASTM D 5882 "Standard Test Method for Low Strain Integrity Testing of Piles".

The pile top velocity is displayed as a function of time with an exponentially increasing magnitude where high soil friction forces are present, such that the pile toe reflection is enhanced. Several records with consistent signals should be averaged. The averaged, amplified velocity shall be standard result of the Pulse Echo Method.

12.10.1.3 **TEST EQUIPMENT**

The test should be performed using digital data acquisition equipment. The signal conditioning and power supply must have very high signal-to-noise ratios to discern the reflected signals for long piles (and/or piles in high friction soils). The analog to digital resolution shall be at least 16 bits, and the sampling frequency at least 25,000 Hz. Data should be stored such that additional processing or further wave analysis is possible. The data must be displayed in the field for evaluations of preliminary data quality and interpretation. The apparatus shall include a graphic display of velocity. The equipment & software used for test and its data processing shall be compliant with ASTM D5882. The equipment shall have a provision of display of data on the field for preliminary evaluation and interpretation and the field print out shall also be feasible. The test agency shall deploy adequate number of equipment & spares to meet contingencies and achieve the desired progress of work to meet construction schedule.

12.10.1.4 **TEST PREPARATION**

Integrity testing shall be performed after the concrete has cured for a minimum of seven (7) days. The pile head shall have sound concrete, free from water, dirt or other debris and reasonably flat surface. The concrete at the pile top surface must be relatively smooth with sufficient space for both attachment of the motion sensing device 300mm away from the center and hammer impact area at the center of the pile.

Piles for integrity testing shall be selected by NPCIL.

The projecting re-bars need to be bent outside for easy access within core region. Safe and reasonable access to the pile is the responsibility of the contractor.

The data supplied to expert test agency at the time of test shall include length of the pile from testing level, cutoff level of the pile, pile diameter and pile reference as well

as location. Soil information available for the location or in the vicinity shall be provided for valuable interpretation of test results. Additional data like pile installation records, load test results etc., shall also be supplied to the test agency.

12.10.1.5 **DATA PROCESSING**

The data collected using test equipment shall be processed using compatible software. To ensure that the signals are clearly visible for interpretation, data shall be processed in terms of Magnification (MA to enhance the energy lost), reduce reflections from soil to evaluate concrete (HI PASS Filter), and reduce reflections from reinforcement (Wavelet Filter). The MA shall be a factor of the length of the pile and normally must be equal to the pile length. The magnification delay shall be default 20% to avoid errors in interpretation.

12.10.1.6 **RESULT PRESENTATION**

The testing agency shall submit test report within 2 working days, after performing the field test, clearly indicating the result of test results and Pile Integrity evaluation and further recommendations. For each pile tested, the averaged, amplified velocity versus time record shall be included in the report, with a table summarizing results and conclusions. On completion of field testing, a report shall be submitted and shall clearly describe the following:

- Uniformity of pile changes in cross-section qualitatively i.e. bulge or defect due to necking, etc.
- Sudden changes in soil stratum based on soil profile and graphs.
- Concrete quality in terms of wave speed.

12.10.1.7 **ACCEPTANCE AND REJECTION**

The report shall clearly indicate that tested piles are acceptable or questionable or needs to be rejected. The comments shall generally be based on the following guidelines.

1. Piles with toe response and no defect apparent shall be classified as acceptable.
2. Piles with no toe response and significant reduction or defect above the pile toe shall be rejected and replacement or any other remedial action may be considered. The test engineer should specify the approximate location of defect in such a case.
3. Piles with a sudden major increase in resistance or impedance may not show toe response and are termed as inconclusive and a typical such pile can be selected for static / high strain dynamic test at the discretion of the Engineer.
4. Piles that show toe response but some impedance reduction / defect maybe under-rated / replaced / repaired / or subjected to additional high strain dynamic or static testing at the discretion of the Engineer.

Acceptance / rejection of piles in 3 and 4 above shall also be based on construction records.

Construction records (concrete usage, grout pressure records, soil borings etc.) may be valuable in result interpretations. Based on the Expert agency recommendation, the decision to either reject and replace, or repair, any defective pile shall be taken by the NPCIL and replacement / remedial measure of such piles at no extra cost to NPCIL shall be binding on Contractor.
If the pile top appears questionable, further pile top cut-off and retesting may be advisable.
If a majority of piles diagnose as "inconclusive", partial or even complete pile excavation or another test method may be necessary for pile acceptance.

12.10.1.8 **REMEDIAL ACTION**

Rejected or questionable piles may be replaced or retested (e.g., static load testing, dynamic load testing, core drilling, ultra-sonic logging, etc.) based on the test results and recommendation of expert agency and as approved by NPCIL.

Remedial action may include pressure grouting through core holes wherever feasible as approved and accepted by NPCIL at contractor's own cost. The repaired piles shall be re-tested and accepted subject to qualifying the test. The cost of such re-testing shall be borne by the contractor.

12.10.2 CROSSHOLE SONIC LOGGING (CSL) BORED CAST-IN-SITU PILES

12.10.2.1 GENERAL

CSL testing shall be performed by sending ultrasonic pulses through concrete from one probe to another (probes located in parallel tubes). The CSL procedure inspects the structural integrity of the pile concrete between the tubes, and extent and location of defects, if any.

This work shall consist of furnishing all materials, equipment and labor necessary for conducting CSL tests on drilled and cast-in-place piles (hereafter each noted as test piles). The contractor shall be responsible for conducting the test through approved expert agency, including supply of material and labour as hereinafter specified and including prior to, during, and after the load test.

CSL testing is a non-destructive quick test and it is intended that the test pile be left in a condition, suitable for use in further construction and may be used as part of structure.

12.10.2.2 TEST METHOD & REFERENCE CODE

The Pile shall be instrumented & Tested as per recommendations of ASTM 6760 "Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Cross hole Testing" unless noted otherwise.

Both the time between pulse generation and signal reception ("First Arrival Time" or "FAT") and the strength of the received signal give a relative measure of the quality of

concrete between transmitter and receiver. Dividing the distance between transmitter and receiver by the FAT value yields the approximate concrete wave speed which also is a relative indicator of concrete quality. For equidistant tubes, uniform concrete between the test tubes yields consistent arrival times with reasonable pulse wave speed and good signal strengths. Non-uniformities such as contaminated or soft concrete, honeycombing, voids and inclusions exhibit delayed arrival times with reduced signal strength.

12.10.2.3 TEST EQUIPMENT

The Contractor shall supply all materials and equipment required to prepare the test pile and restore the pile to a condition suitable for use in the permanent structure, wherever specified by the Engineer. Equipment required to perform the test includes but is not limited to following:

Provide a Cross Hole Analyzer (CHA) manufactured by Pile Dynamics, Inc., or equivalent CSL equipment. The equipment shall have the following minimum requirements.

1. A computer based CSL data acquisition system for display of signals during data acquisition, with a minimum 12 bit A/D converter with a sampling frequency of at least 250000 Hz, and recording of all pulse signals for full analysis and individual inspection. (Note: Converting signals with low noise using high A/D resolution and sampling rates is important to obtain quality data and allow proper full data interpretation.)

2. Ultrasonic transmitter and receiver probes with probe centralizer and signal transmission cables as per ASTM6760 capable of generating pulse with a frequency between 30,000Hz to 100,000Hz with good signal amplitude and energy through good quality concrete. The probes shall be less than 30mm in diameter and shall freely descend through the full depth of properly installed sonic logging tubes of at typically less than 50 mm diameter, in the piles.

3. Two depth sensors to independently determine transmitter and receiver probe depths.

4. Triggering of the recording system time base with the transmitted ultrasonic pulse.

12.10.2.3.1 Sonic Logging Tubes:

All Piles required to be tested shall be provided with sonic tubes for sonic logging tests cast into it. The tubes shall be manufactured from mild steel tubes. To form a single tube the pipes to be connected with Bell Mouth – push fit arrangement only. PVC or any kind of plastic material is strictly prohibited due to different coefficient of thermal

expansion with respect to concrete which may affect the test result. The tubes should be of 50mm Internal Diameter and 1 mm thick.

Tests to be conducted for Sonic Tubes assembly and desired results.

The Sonic Tubes assembly should be tested for following tests:

a) External Pressure Test

The minimum 50 mm inside diameter tube, minimum 1 mm wall thickness should be applied with external pressure up to 5 Mpa . Following are the desired results:

Description	Pressure in Mpa	Hold Time	Desired Results
Sonic Tubes Diameter 50 mm X 1.0 mm Thick	>= 5 MPa	>= 60 Sec	No Leakages from Inner Surface of Tubes and No Distortion of Tubes

Minimum 3 test results should be obtained.

b) Pull Out Test for Tubes

Description	Tensile Force to be applied	Desired Results
Sonic Tubes Diameter 50 mm X 1.0 mm Thick	>= 0.5 KN	No Distortion / Elongation of Tubes till test load of 0.5 KN.

c) Pull out test for Joint

Description	Tensile Force to be applied	Desired Results
Sonic Tubes Diameter 50 mm X 1.0 mm Thick, Bell Mouth – Push Fit Joint.	>= 0.5 KN	Joint should withstand the Pull out load of 0.5 KN.

d) Pull Out Test for tubes 'Fixing Ears'

Description	Tensile Force to be applied	Desired Results
Sonic Tubes Diameter 50 mm X 1.0 mm Thick	>= 0.5 KN	Fixing Ears should withstand the Load up to 0.5 KN.

e) Crush Test

For 50 mm diameter and 1 mm tick Tube following is the criteria for Crush test.

Sr. No.	Descriptions	Test	Desired Results
1	Direction tube	1500 mm	No Cracks After test 30 mm Steel ball can go through the tubes.
2	Drop Weight	4000 + 150/-0g	
3	Diameter of Drop	m	

12.10.2.4 CSL ACCESS TUBE PREPARATION

Every drilled shaft shall be equipped with sonic logging tubes to permit possible inspection by CSL. Drilled shafts with different diameters at the same site may require a different number of sonic logging tubes. Sufficient number of sonic logging tubes shall be installed in all the Piles (minimum 2 nos.) prior to concreting as given in the drawing based on the Pile Diameter. The Number of tubes shall be generally one tube for every 0.3m of drilled shaft diameter unless specified otherwise, but not less than 2 nos. in any case.

The number of piles to be tested by CSL shall be as specified in drawings. If not specified in the drawing, minimum 20% of the piles shall be subjected to this test or as decided by Engineer.

The parallel steel tubes shall be supported and braced securely so that they maintain their position during the subsequent operations. The splice connection of parallel pipes shall be of good quality, easy installation and proven water-tight performance having Bell-Mouth Socket system with rubber gasket joint unless mentioned and approved otherwise.

The couplings locations shall be properly recorded. Tubes shall be installed by the Contractor in a manner such that the CSL probes pass through the entire length of the tube without bending. Ensure that the sonic logging tubes are in plumb and verify that unobstructed passage of the probes is achievable.

The Sonic logging tubes shall be fitted with a watertight shoe on the bottom and a removable cap on the top. Tubes shall be secured to the interior of the reinforcement cage at regular intervals not to exceed (1.0m). Tubes shall be installed uniformly and equidistantly around the circumference such that each tube is spaced parallel for the full length and at the maximum distance possible from each adjacent tube. Tubes shall be spaced as far as possible from the main axial reinforcing steel. The bottom end of the Tubes shall be kept approx. 100 mm above the bottom of the drilled shaft , and the top end shall be at least (1.0m) above the top of the concrete of the Pile, and to at least (0.6 m), but not more than (1.5m) above the ground surface. Tubes shall not be damaged during installation of the reinforcement cage.

The tubes should preferably be filled with water prior to concrete placement, in any case it must be filled with water within at most 1 hour after placing concrete to prevent de-bonding of the sonic logging tubes from concrete, due to differential temperatures. The top of the tubes shall be capped to prevent debris from entering the sonic logging tubes. Excessive torque, hammering or other stresses which could break the bond between the tube and concrete when removing caps from the tubes shall be avoided.

12.10.2.5 TIMING OF THE CSL TEST

The pile shall be tested no sooner than seven (7) calendar days after placement of all concrete (having minimum compressive strength as 2/3rd fck) and preferably within 90 days after casting of pile. The concrete strength and quality generally increases as the concrete cures, longer wait times are usually desirable. After all CSL testing has been completed, and after acceptance of the pile by NPCIL Engineer, the Contractor shall remove the water in the tubes, place grout tubes extending to the bottom of the access tube, and fill all sonic logging tubes in the pile with cement sand grout.

12.10.2.6 PROCEDURE

Prior to CSL testing, the Contractor shall provide the expert test agency with a record of all pile lengths with elevations of the top and bottom, and installation dates of all piles. The sonic logging tubes shall be clearly labeled for identification. The CSL testing shall be performed with the transmitter and receiver probes in the same horizontal plane in parallel tubes.

Using the labeling established for the tubes, CSL testing shall be performed between all adjacent perimeter access tube pairs and across at least all major diagonals within the pile.

Probes shall be lowered from the top, effectively measuring the access tube lengths. Probes shall be pulled simultaneously, with CSL measurements taken at intervals of 50 mm or less from the bottom to the top of the pile. Defects indicated by late pulse arrival times and significantly lower amplitude/energy signals shall be immediately reported to NPCIL Engineer. The equipment used for test shall be properly maintained and calibrated.

The tests shall be repeated for each pair of tubes, i.e. three runs for a pile with three tubes and six runs for a pile with four tubes.

12.10.2.7 REPORTING OF RESULTS

A report shall be prepared for each pile tested. The photographic record of the oscilloscope displays shall be analyzed in detail. Any deviation from the record to be expected from a pile constructed entirely of sound concrete and without defect shall be reported. The report shall indicate the nature, location and severity of the defect and recommendations shall be made for further testing. The implication of the existence of the defect on the performance of the pile shall be evaluated.

Results of the CSL shall be presented in a written report within five (5) working days of completion of testing. The report shall include presentation of CSL logs for all tested tube pairs including:

1. Presentation of the traditional nested signal peak (e.g. "waterfall") diagram as a function of time plotted versus depth.
2. Computed pulse first arrival time (FAT) or pulse wave speed versus depth.
3. Computed relative pulse energy or amplitude versus depth.

A CSL log shall be presented for each tube pair. The rating of the shaft integrity considers the increases in "first arrival time" (FAT) and the energy reduction relative to the arrival time or energy in a nearby zone of good concrete. Pile is classified as satisfactory/ good provided the evaluation criteria for FAT increase and energy reduction are met. Pile is classified as having minor defect or poor concrete if either evaluation criteria of FAT increase or energy reduction are met. The criteria for evaluation of the concrete from the CSL test are given below.

Pile Classification	FAT Increase relative to good concrete	Energy reduction relative to good concrete
Satisfactory / Good	0-10%	<6 db
Minor Defect	11-20%	<9 db
Poor/Flaw	21 to 30%	<9 to 12
Poor/Defect	>31%	>12

Flaws must be addressed if they affect more than 50% of the profiles. Defects must be addressed if they affect more than one profile (a profile is the result of complete investigation from bottom to top between two tubes) at the same cross section. Flaws or Defects covering the entire cross section define a full layer concern requiring repair.

Immediately after testing, a signed copy of all the raw test data of a pile shall be handed over to the Engineer.

The piles with anomalous sonic logging results shall be rejected at the Engineer's discretion unless the contractor is able to demonstrate that the pile integrity is acceptable through proof coring.

12.10.3 HIGH-STRAIN DYNAMIC TESTING OF BORED CAST-IN-SITU PILES

12.10.3.1 GENERAL

High-strain dynamic testing shall be performed by obtaining and analyzing the records of pile force and velocity under drop weight impacts for evaluations of pile load carrying capacity, structural integrity, and load-movement and pile-soil load transfer relationships.

This work shall consist of furnishing all materials, equipment and labor necessary for conducting high-strain dynamic tests on bored cast-in-place piles (hereafter each noted as test piles). The contractor shall be responsible for conducting the test, including supply of material and labor as specified and including prior to, during, and after the load test.

High-strain dynamic testing is a non-destructive quick test and it is intended that the test pile be left in a condition, suitable for use in further construction and may be used as part of structure.

12.10.3.2 **TEST METHOD & REFERENCE CODE**

The Pile shall be instrumented & Tested as per recommendations of ASTM D 4945 'Standard Method of test for High Strain Dynamic Testing of Piles' unless noted otherwise.

12.10.3.3 **EQUIPMENT**

The test shall be conducted by the contractor through an approved expert agency. The Contractor shall supply all materials and equipment required to prepare the test Pile, dynamically load the Pile, and restores the pile to a condition suitable for use in the permanent structure, wherever specified by the Engineer. The test shall be conducted using Pile Driving Analyzer (PDA) to obtain and analyze the records of force and velocity under drop weight impacts. The field results shall be further analyzed with a signal matching technique such as CAPWAP (Case Pile Wave Analysis Program) or equivalent to refine the soil parameter assumptions.

In case of uncased pile – The Pile top shall be extended using a thin walled casing or equivalent, by a length equal to two pile diameters unless specified otherwise. This top length, shall be defined as the "test area" must be exposed and ready for test. Wherever the Pile top is below grade, the Contractor must remove surrounding soil (creating a safe working environment) so as to completely expose a test area of the Pile suitable for conducting the test to the satisfaction of expert agency engaged for the test. Windows on four opposite sides of the Pile have to be cut off in the steel casing to reach the concrete. The size of the windows shall be as suiting to the requirements of test agency and as approved by the NPCIL Engineer.

The pile top concrete shall be leveled above the casing. A drop weight shall be in the range of one to two percent (1 - 2%) of the anticipated pile capacity, or as determined by the expert agency and approved by the Engineer. A guide allowing variable drop heights typically between 3 and 13 ft (1 to 4 m), or as determined by the expert agency and approved by the Engineer shall be used for test.

Pile top cushion shall consist of new sheets of plywood with total thickness between 2 to 6 inches (50 to 150 mm), or as determined by the expert agency and approved by the Engineer.

A steel striker plate with a thickness of at least 2 inches (50 mm) and an area between 70 to 90% of Pile top area but not less than the area of the impacting surface of the drop weight to be placed on top of the plywood cushion.

Surveyors' transit, laser light, or equivalent for measurements of pile set under each impact.

12.10.3.4 **PROCEDURE**

a) The test Pile shall be constructed using the approved installation techniques.

b) If a permanent casing is not required, then the upper length equal to two Pile diameters, noted as the "test area", must be cased in a thin wall tube. Casing of this test area must be made as a continuation of the construction of the Pile.

c) Wherever, reinforcing bars are protruding out, the same shall either be encased within the concrete in the test area and on successful completion of the dynamic test, the surrounding concrete can then be removed to expose the bars using the same suitable for further construction, or a steel beam or pipe (cross sectional area approximately 20% of the Pile cross sectional area) shall be supplied with sufficient length such that the ram impact will not interfere with the reinforcing bars. Steel striker plates and plywood cushion must also be sized so that they cover as much of the impact area as possible. However, either of the above option shall be finalized in consultation with expert test agency with the prior approval of NPCIL Engineer.

d) There should not be any soil contamination or non-uniformities in the concrete located within or below the test area. Pile top shall be made level to the casing and smoothed.

e) Prior to testing time, the Contractor shall make the Pile test area length completely accessible to the suit the test.

f) Prior to the test four "windows" (approximate size of 6 by 6 inches (150 by 150 mm) diametrically opposite of each other shall be located and removed from the casing.

g) In cases where casing is not present, the circumferential area where transducer is to be fixed, shall be smoothened by grinding.

h) Gauges shall be attached to the exposed concrete or steel casing in a secure manner as to prevent slippage under impact.

i) Pile top should be examined to ensure that the concrete top is flush with or above the casing in any case it should not be below the casing level.

j) Apply plywood cushion and then striker plate to the Pile top.

k) At least two (2) hammer impacts should be applied to the pile top. First drop height should be minimal to assess the testing equipment, the driving system and pile stresses. Subsequent impacts can then be applied by utilizing higher drop heights.

l) Upon completion of the test, it is the Contractors' responsibility to return the pile to acceptable condition in a manner that the same can be used as part of structure.

12.10.3.5 **REPORTING OF RESULTS**

The Expert Agency shall submit a report of the field test results with its finding. In addition to the field results, results from at least one (1) set of wave equation analysis using CAPWAP or equivalent shall be submitted. The analysis shall be performed by same expert agency involved in the testing. The report must also provide the following:

1. Wave Equation analysis results obtained prior to testing.
2. Wave equation analysis results with a match quality preferably up to 5. If match quality is less than 5, reasons must be outlined for the same before acceptance by NPCIL.
3. For each impact, the maximum measured force, maximum calculated tension force, energy transferred to the gauge location, corresponding stresses, and the bearing capacity shall be tabulated.
4. Assessment of the test results both with respect to pile capacity and integrity.

The output from the test result shall provide:

a) Static capacity of the pile at the time of testing.
b) Simulated static load test curve
c) Total skin friction and end bearing of the pile
d) Skin friction distribution along the length of the pile
e) Compressive and tensile stresses developed in the pile during testing
f) Net and total displacement of the pile.
g) Pile integrity

12.10.4 EXPERT AGENCY TO PERFORM THE NDT ON PILES

The testing method and interpretation requires expertise and through understanding of wave mechanics. The agency employed for testing shall prove its competency by submitting previous reliability studies between static and high strain dynamic tests.

Contractor shall engage an Expert Agency of national repute and shall be approved by the NPCIL, to conduct the test. The Expert Agency shall be specialist having minimum of 5 years of experience in low & high strain integrity testing as well as sonic logging testing of the piles. The expert agency shall have sound knowledge of Wave Theory used for analyzing and interpretation of test results and at least performed minimum 5 nos. of correlation studies of Dynamic Pile Load Testing with conventional load test in various strata covering friction piles. The results of the correlation studies should have been accepted by the owners of the project, for whom tests were performed. Demonstration of case studies/correlation between CSL and HSDPT or PIT will be preferred. Performance certificates for completed projects shall be submitted.
The Expert Agency is required to perform wave equation analyses (using CAPWAP or equivalent) to determine the suitability of the proposed dynamic loading equipment and an acceptable range of ram drop heights so as not to cause damage in the pile during

the test. Performance certificates for completed projects shall be submitted. CV of the personnel carrying the test shall be submitted before performing the test.

The expert agency must possess, the following testing instrumentation in addition to that outlined in ASTM D 4945 Section 5: and other ASTM, in order to meet the project schedule and to maintain the redundancy. The test agency shall deploy adequate number of equipment & spares to meet contingencies and achieve the desired progress of work to meet construction schedule.

1. Pile Driving Analyzer (PDA)
2. Pile Integrity Testing Equipment.
3. Cross Hole Testing Equipment for Sonic Logging.
4. Required nos. of calibrated strain transducers.
5. Required nos. of calibrated accelerometers.

All other test equipment required for to conduct the above tests. The equipment and sensors shall be properly calibrated and the testing agency shall be able to obtain the calibration certificates upon request or prove the internal calibration of the system on site.

The Expert Agency shall study the Bore Log Data applicable to the test location, prior to perform the dynamic test, Pile installation records, concrete properties (strength, etc.) and submit the details regarding the anticipated dynamic loading equipment.

13 GROUT/ DRY PACK

13.0 General

Grout / Dry Pack shall be provided as specified on the drawings. The proportion of Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage.

Concrete surfaces to be grouted / dry packed shall be thoroughly roughened and cleaned of all foreign matter and laitance. Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot strong caustic solution for this purpose may be permitted.

Prior to grouting/dry packing, the hardened concrete surfaces shall be saturated with water.

Forms around base plates shall be reasonably tight to prevent leakage of grout/dry pack. Adequate clearance shall be provided between formwork and base plate, to permit grout/ dry pack to be worked properly into place.

Grouting, once started, shall be done expeditiously and continuously to prevent segregation, bleeding and within the initial setting time. Grout shall be worked from one side to the other, to prevent entrapment of air.

Water in anchor bolt holes shall be removed before grouting is started.

Forms and shims shall not be removed and the anchor bolts shall not be tightened for at least 24 hours after placing the grout. After the removal of forms and peripheral shims, area occupied by shims shall be filled and the area between the base and the edge of the foundation shall be finished smooth to allow drainage away from the base. Interconnecting piping and machinery shall not be attached to the machinery before anchor bolts are tightened. It is desirable to make these connections at least after a minimum of seven days from the date of grouting. During this period, the grout shall be properly cured.

13.1 Dry Pack

The dry pack shall consist of 1:2.5 (Cement: Sand), sand passing through 1.18 mm square hole opening standard sieve. Only enough water shall be added to produce a mortar, which will stick together when moulded into a ball by a slight pressure of hand and will not extrude water but will leave the hands just damp. Dry pack material shall be placed and packed in layers having a compacted thickness of about 10mm. Each layer shall be solidly compacted over the entire surface by use of hardwood stick and hammer. Sand for this job shall be as pure as specified for concrete making.

13.2 Grout

13.2.1 Normal Grout

The contractor shall supply and place normal grout consisting of an approved mixture of cement, normal fine aggregate, water, admixture and when specified by the Engineer, a non-shrink agent. Normal grout shall be placed as shown on the drawings or specified by the Engineer.

Grouting through holes in base plates shall be, by pressure grouting. The pressure to be used for grouting shall be as directed by the engineer. The grout proportions shall be as follows:

Mix proportion	**W/C Ratio(max)**
Mix 1:1 Cement: Sand grout with anti shrink compound	0.44
Mix 1:2 Cement: Sand grout with anti shrink compound	0.44
Mix 1:1:2 cement: sand with 6mm down stone chips and anti shrink compound	0.44

Note: If the requirement arises, mixes other than the specified above, such as mix 1:1.5, 1:1.75, 1:2.25 etc. shall be used with the approval of the Engineer.

The W/C ratio shall be as per the manufacturer’s recommendation and in no case shall exceed the values specified above.

13.3 Inspection

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Engineer

All materials supplied by Contractor and all works or construction performed by Contractor and rejected - as not in conformity with the specifications and drawings - shall be immediately replaced at no additional expense to NPCIL.

Preliminary approvals of any materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying grouting materials and or producing finished grout in accordance with the specifications and drawings.

All grouting shall be protected against damage until final acceptance by NPCIL or his representative.

Upon the completion of grouting work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area as directed by the Engineer.

13.4 GROUT / DRY PACK FOR EQUIPMENT BASES

13.4.1 SCOPE

Scope of work covered in this specification includes supply and place normal free flow grout / dry pack at all places below equipment base plate, structural steel base plates / bearing plates, anchor bolts, pockets and other areas. Normal cement sand grout in various proportions with anti-shrink compound, non-shrink cementitious precision grout and dry pack with cement sand in proportion of 1: 2.5 are included in this specification.

13.4.2 GENERAL

13.4.2.1 Grout/ Dry Pack shall be provided as specified in the drawings. The proportion of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage.

13.4.2.2 Concrete surfaces to be grouted/ dry packed shall be thoroughly roughened and cleaned of all foreign matter and laitance. Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

13.4.2.3 Prior to grouting/ dry packing the hardened concrete surfaces shall be saturated with water.

13.4.2.4 Forms around base plates shall be reasonably tight to prevent leakage of grout/ dry pack. Adequate clearance shall be provided between formwork and base plate, to permit grout/ dry pack to be worked properly into the place.

13.4.2.5 Grouting, once started, shall be done expeditiously and continuously to prevent segregation, bleeding and within the initial setting time. Grout shall be worked from one side to the other, to prevent entrapment of air.

13.4.2.6 Water in anchor bolt holes shall be removed before grouting is started.

13.4.2.7 Forms and shims shall not be removed and the anchor bolts shall not be tightened for at least 24 hours after placing the grout. After the removal of forms and peripheral shims, area occupied by shims shall be filled and the area between the base and the edge of the foundation shall be finished smooth to allow drainage away from the base. Interconnecting piping and machinery shall not be attached to the machinery before anchor bolts are tightened. It is desirable to make these connections at least after a minimum of seven days from the date of grouting. During this period, the grout shall be properly cured.

13.4.3 DRY PACK

The dry pack shall consist of cement and sand in proportion of 1: 2.5. Sand passing through 1.18 mm square hole opening standard sieve shall be used in the dry pack. Only enough water shall be added to produce a mortar, which will stick together when molded into a ball by a slight pressure of hand and will not extrude water but will leave the hands just damp. Dry pack material shall be placed and packed in layers having compacted thickness of about 10 mm. Each layer shall be solidly compacted over the entire surface by use of hardwood stick and hammer. Sand for this job shall be as pure as specified for concrete work.

In case of heavy cement sand dry pack, heavy sand shall be used in place of normal sand.

13.4.4 NORMAL GROUT

13.4.4.1 The Contractor shall supply and place normal grout consisting of an approved mixture of cement, normal fine aggregate, water, admixture and when specified by the Engineer, a non-shrink agent. Normal grout shall be placed as shown in the drawings or as specified by the Engineer.

13.4.4.2 Grouting through holes in base plates shall be by pressure grouting. The pressure to be used for grouting shall be as directed by the Engineer. The grout proportions shall be as follows:

Mix Proportion		**W/C Ratio (Max)**
Mix 1:1	Cement: Sand with anti-shrink compound	0.44
Mix 1:2	Cement: Sand with anti-shrink compound	0.44
Mix 1:1:2	Cement: Sand with 6mm down stone chips and Anti-shrink compound	0.44

NOTE:

1. If the requirement arises, mixes other than the specified above, such as mix 1:1.5, 1:1.75, 1:2.25, etc. shall be used with approval of the Engineer.
2. The W/C ratio shall be as per the direction of Engineer and in no case shall exceed the values specified above.

13.4.5 NON-SHRINK CEMENTITIOUS PRECISION GROUT

Powdered non-shrink, high strength, free flow cementitious grout complying with the requirements of ASTM C348 & C109 that expands in two stages to counteract the plastic as well as the drying shrinkage normally associated with cement grouts. Mix proportion shall be as per manufacturer's recommendations. The compressive strength of the grout at optimum W/C ratio recommended by Manufacturer shall not be lesser than 55MPa, 65MPa & 75 MPa at 3days, 7days and 28 days respectively. It shall also possess following properties:

Property	**Acceptable Limit**	**Test Method**
Workability	Flowablility:	ASTM C 230
	Instantaneous, 240mm	
	After 20 mm, 220mm	
Setting Time	Initial Set, 4Hrs	IS 4031(Pt-5)
	Final Set, 5hrs	
Compressive Strength, 28 days	75 MPa	ASTM C 109
Tensile Strength, 28 days	8.1 MPa	ASTM C 1107
Flexural Strength, 28 days	9 MPa	ASTM C 378
Coefficient of Thermal Expansion	$11X\ 10^{-6}$ / ^{0}C	
Expansion in Plastic Stage	1.25%	ASTM C 940
Shrinkage	Nil	
Pullout Bond Strength	>17MPa	ASTM D4541

13.4.6 INSPECTION

13.4.6.1 All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer**.** Grout material shall be tested for cube compressive strength both for pre-qualifications and batch qualifications at no extra cost to NPCIL. No material exceeding the shelf life will be used and all such material shall be immediately removed from site.

13.4.6.2 All Materials supplied by the Contractor and all works or construction performed by the Contractor and rejected – as not in conformity with the specifications and drawings shall be replaced at no extra cost to NPCIL**.**

13.4.6.3 Preliminary approvals of any materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying grouting materials and or producing finished grout in accordance with the specifications and drawings**.**

13.4.6.4 All grouting shall be protected against damage until final acceptance by the NPCIL representative.

13.4.6.5 Upon completion of grouting work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area as directed by the Engineer.

14 INJECTION GROUTING

14.0 SCOPE

14.0.1 The Scope of work covered under this specification is injection grouting at the following locations:

a) Where required impermeability of concrete is not achieved.

b) Where defective concrete is suspected and observed.

c) Where water seepage is observed.

d) Construction joints for all underground basements

e) Any other location specified in the drawing or as directed by the Engineer

14.0.2 The Grouting shall be carried out at specified locations as shown in the drawing or as directed by the Engineer

14.1 GENERAL

The injection grouting shall be carried out either through threaded GI nozzles of suitable length fixed in the area to be grouted or through non-return packer type nozzles either installed in the existing GI nozzles or in drilled holes. The nozzle length and spacing shall be as specified in the drawing or as directed by the Engineer. The diameter of the nozzle shall be as per site conditions and generally 16/12 mm diameter may be adopted for cement grouts (without non return valve) and 12 mm diameter (with non-return valve) for epoxy and polyurethane based hydrophilic grouting. The entire scheme shall be duly approved by the Engineer before commencing the work.

14.2 MATERIALS

The grouting material shall be epoxy, cement based with non-shrink additive or polyurethane based hydrophilic material as specified in the drawings, specifications or as directed by the Engineer as per site conditions.

14.3 EPOXY GROUT

14.3.1 The epoxy grout shall comprise of an injectable solvent free, aggregate free, ultralow viscosity, free flowing, two-component epoxy injection resins, which shall be pumped through the nozzles (fixed prior to concreting or drilled after concreting) under pressure and rapidly cure to a high strength material. It shall comply with ASTM C-881-1987 Type I–Grade I Class (B+C) & class F as applicable. It shall be suitable for application in both dry and damp conditions,

14.3.2 The Generic name 'epoxy resin' covers a very diverse range of chemically and physically different polymers. To achieve durable repairs, careful selection of the resin composition appropriate to the application and service condition is essential.

14.3.3 The Proposed resin injection system is required to have following characteristics. The material shall comply with the requirement of ASTM C 881 Type I Grade I Class (B+C) & class F as applicable.

f) It should be two component (resin/hardener), low viscosity, solvent free, aggregate free, injection liquid based on high strength epoxy resin and suitable for deep impregnation. The epoxy and hardener system shall be able to cure in moist/wet conditions also.

g) It should rapidly cure to a high strength, shrinkage free hardening and without embrittlement.

h) It shall possess anti corrosion property, good adhesiveness and bond with the concrete with adhesive strength both under dry and damp conditions and should be capable for use under extreme ambient conditions and remain fluid during applications.

14.3.4 The proposed resin to be used shall be of two parts preferably supplied in different containers according to the manufacturers recommended proportions indicating identifications such as base hardener, recommended proportion, batch number, shelf life, date of manufacturing, grade, type, class, quantity, etc. Each batch shall invariably carry test certificates as per table 14.1 for tests conducted in NPCIL approved laboratory. The Engineer may at his discretion, appoint his representative to witness these tests at the laboratory. No separate payment will be made for testing. The chemical composition of epoxy resin constituent of component 'A' shall have an epoxy equivalent of 160-275 g/g mole and physical requirements shall be in line with ASTM C-881. A sample of proposed material intended to be used shall be supplied by the Contractor to the Engineer to verify the required parameters. The material shall be generally used within six months from the date of manufacture or date of expiry whichever is earlier.

TABLE - 14.1

LIST OF TESTS TO BE CONDUCTED AS PER ASTM C-881

SI. No	Property	Tested as per ASTM No.	Requirement
1.	Viscosity	D – 2393	2* poise (Max)
2.	Bond Strength		
	2 days (moist cured)	C – 882	10 N/mm^2 (Min)
	14 days (moist cured)	C – 882	14N/mm^2 (Min)
3.	Water Absorption (24 hours)	D – 570	1.0% (Max)
4.	Compressive strength 7 days	D – 695	70N/mm^2 (Min)
5.	Tensile strength 7 days	D – 638	50 N/mm^2 (Min)
6.	Flexural Strength	D – 638	55N/mm^2 (Min)
7.	Full Chemical Cure	7 days at 20 ^{0}C	
8.	Slant Shear Bond Strength 7 days	C-881	18N/mm^2 (Min)
9.	VOC Content	ISO11890-2	<1.5%
10.	Elongation at break	D638	2% (Min)

* Please note that requirement of viscosity is in variance with ASTM C-881.

14.4 CEMENT BASED GROUT

14.4.1 CEMENT AND WATER

The cement shall be Ordinary Portland Cement 43 Grade conforming to IS 8112. It shall be mixed with water to achieve required consistency for pumping. The quality standards of water to be used shall be same as that of RCC works.

14.4.2 ADMIXTURES

To achieve high consistency with low water cement ratio of around 0.3, suitable water reducing admixture as approved by the Engineer may be used. Suitable anti shrinkage compound shall be added in the mix if specified or as directed by the Engineer.

Proportion of cement & water shall be as directed by the Engineer. Quantity of admixture and type of mixing shall be as per manufacturer's instructions. Compatibility of admixture with the type of cement used shall be ascertained before use of any admixture with cement.

Typically the properties of the resulting mix shall exhibit the following properties:

PROPERTY	ACCEPTANCE VALUE	TEST METHOD
Flow Cone test using Marsh Cone	23 secs at mix time	ASTM C 939
	34 secs after ½ hr	
	39 secs after 1 hr	
Specific Gravity	2.06	ASTM C 939
Setting time using Vicat's Apparatus	4 hrs for Initial Set	ASTM C 939
	5Hrs for Final Set	
Expansion	500 μm/m	ASTM C 878
Bleed Water	0.16%	ASTM C 232
Water Retention	96%	ASTM C 91

14.5 POLYURETHENE BASED HYDROPHILLIC GROUT

The material shall be one component high grade, low viscosity polyurethane injection foam resin which expands its volume to cure to very dense foam upon contact with water. This material shall be used to arrest excessive seepage of water through the concrete. Approval of the Engineer shall be obtained for the material, before use. The typical properties of the low viscosity polyurethane grouts are as follows:

PROPERTY	**ACCEPTANCE VALUES**
Density (at 20 ^{0}C)	1.16
Viscosity (at 23 ^{0}C)	320 mPa.s
Flash Point	180 ^{0}C
Application Temperature	+5 ^{0}C to 40 ^{0}C
Max foam expansion rate@10% accelerator dosage	25-30

14.6 GROUTING OPERATIONS

Grouting operations shall normally begin after six weeks of the last concrete poured. A high-speed mechanical mixer shall be used to mix the epoxy grout as per manufacturer's recommendation. The grouting shall be done by using hand pump and pressure will be decided based upon the nature of work and grade of concrete, or as directed by the Engineer. The grouting range can be achieved by injecting the grout with initial low pressure proceeding further with increasing pressure gradually. Slow and steady increase in pressure shall be followed to produce uniform impregnation of the zone under treatment. The injection pump shall be connected to the lowest tube and the injection allowed to proceed at gradually increasing pressures until grout appears at the adjacent/higher point or refusal of further grout entry at the operating pressure. Cement grouting shall be done normally starting with lean mix and slowly increasing the richness of mix. Cubes shall be cast to test the strength of the cement grout as directed by the Engineer. After successful completion of grouting the nozzles shall be cut and ground properly and finished with dry packing. Wherever specified in the drawing, Contractor has to make suitable arrangements for placement of nozzles prior

to concreting for its rigidity, thoroughness etc. complete with or without piercing through formwork. Contractor has to arrange adequate equipment/ manpower required for the work to carryout grouting in different areas simultaneously. Contractor at his cost may appoint a specialized agency to carry out grouting works. Detailed procedure of grouting shall be prepared by the Contractor and submitted to the Engineer for approval before commencement of work.

14.7 GROUTING AROUND PENETRATION EPs HAVING DIAMETER ABOVE 300 MM

Grouting is required to be done around penetration EPs having diameter above 300 mm and some special EPs. Procedure for grouting shall be generally same as above with the grouting pressure not exceeding the specified value in the drawing. The nozzles for grouting may be placed prior to concreting and the length and diameter of the nozzles shall be as given in the drawing.

15 CAULKING AND SEALANTS AROUND PENETRATIONS

15.0 SCOPE OF WORK

Scope of work covered under this specification is caulking of expansion joints, around embedded parts, penetrations and construction joints at various locations in all buildings as shown in the drawings and as directed by the Engineer.

- Caulking and sealing around penetrations.

15.1 MATERIAL

15.1.1 Polysuphide sealing compound shall conform to BS: 4254 and PP-M-400.

15.1.2 Epoxy quartz sand caulking compound shall be as per manufacturer’s specifications.

15.1.3 Bituminous sealing compound (bitumen-polymer cold mastic) conforming to IS:1834-1984 Grade-B (working temperature 155°C to 165°C and density of 1200 kg/cu.m).

15.2 DESCRIPTION

Before proceeding with caulking, the grooves shall be cleaned for dirt, dust and grease if any. The grooves shall be finished to line and level.

15.3 CAULKING WITH POLYSULPHIDE SEALING COMPOUND

15.3.1 GENERAL

The work to be done under this specification covers the supply and applying of caulking polysulphide base sealing compounds and primer, all in accordance with the requirements of this specification together with PP-M-400. Installation of the material will be done by the Contractor as per drawing, specification and direction of Engineer.

15.3.2 REFERENCES

ASA	:	116-1
ASTM	:	D676-59T
ASTM	:	1191-52
TTS	:	227 b
ASTM	:	E42-69
BS	:	4254
PP-M-400	:	NPCIL Specifications.

Wherever, this specification is at variance with the requirements mentioned in the above references, this specification shall govern.

15.4 DESCRIPTION

Materials covered under this specification are two-package system consisting of polysulphide base compound and an accelerator compound. The compounds shall be stable separately and when properly mixed, convert to a rubber like solid, which meets the requirements specified herein. The selection of base polymers, fillers and other components shall be optional with supplier, but shall be suitable for the application intended. Properties of base polymer should be similar to Thiokol and have low molecular weight. The consistency of the compound should be plastic.

15.5 INTENDED USE

The sealing compound is proposed to be used for caulking construction joints in RCC walls, slabs and expansion joints. The caulking may also be required around some embedded parts and concrete hatch covers. Size of 'V' groove to be caulked in construction may vary in size from 12 mm X 12 mm to 25 mm X 40 mm while the rectangular gap to be caulked in expansion joints may vary from 25 mm X 10 mm to 75 mm X 10 mm thick. The sizes given above are approximate only and intended to give general idea of work involved.

15.6 CLASSES OF MATERIAL

The sealing compound shall be applied in two classes as follows:

a) Class-A (Self-Leveling): shall be compound which when properly accelerated has sufficient flow to give a smooth level surface when applied in horizontal joints at ambient temperatures between 40°F & 120°F. The compound should also permit its application in joints sloped up to 1:10.

b) Class-B (Non-Sag): shall be compound which when properly mixed permits application in vertical joints, without sagging at ambient temperatures between 40°F & 120°F.

15.7 COLOUR

The sealing compound may be supplied in any colour as agreed upon by the supplier and NPCIL.

15.8 MATERIAL REQUIREMENTS

Application life: A properly mixed compound shall be suitable for satisfactory application for at least 4 hours when maintained at a temperature of 77° ±2°F and relative humidity of 50% ±5%. It shall also be suitable for at least 1 hour when at a temperature of 110°F.

Stability: The base compound and accelerator in original unopened containers shall be stable for at least one year from the time of delivery when stored at a temperature not exceeding 110°F. When tested at the end of one year after the time of delivery, the compound shall meet the requirements specified herein.

Temp. Range performance: Continuous exposure 40 to 175°F
Continuous exposure 40 to 250°F

Recovery: The test assemblies shall be prepared and tested in accordance with ASA 116.1. The recovery of the compound in the test joint shall not be less than 25% within 1 hour at a temperature of 77°±2°F.

Resistance to crazing: The surface of compound of test panel prepared and tested in accordance with ASA 116.1 shall not craze more than 3 mils in depth.

Staining of concrete and masonry: The staining test shall be conducted on a test mortar in accordance with ASA 116.1 and there shall be no staining on the test mortar within 14 days. Staining on the test mortar indicates that the sealant is capable of staining.

Specific gravity: 1.6 to 1.7.

Toxicity: Safe lead content should not exceed 5%.

Properties required for Class A Compounds:

Hardness, Tensile Strength and Elongation

	Shore A Hardness	**Minimum Tensile Strength psi**	**Minimum Elongation %**
Original	35 ± 2	200	350
72 hrs. at 250°F	55 ± 3	325	150

Hardness shall be tested in accordance with ASTM D 676-59T, Tensile strength according to ASA 116.1 and Elongation according to ASTM 1191-.52.

Properties required for Class B compounds:

Sag: When tested in accordance with federal specification no. TTS-227b on a bead of ½" x ¾" there shall be no sag.

Hardness, Tensile Strength and Elongation:

	Shore A Hardness	**Min. Tensile Strength psi**	**Minimum Elongation %**
Original	22 ± 3	40	420
72 hrs. at 220°F	18	48	450
24 hrs. at 30°F	-	> 100	450

The testing method for these properties shall be same as specified for Class 'A' compounds.

Cohesive Strength: Surface-to-Surface Bond

	Aluminium	**Glass**	**Steel**	**Concrete**
Tensile (psi)	45	30	23	45
Elongation (%)	375	350	270	360

Cohesive strength shall be tested in accordance with ASTM 1191-52.

Durability:

Hours in weather-meter	**Equivalent in years**	**Shore A Hardness**	**Elongation %**
1440	5 years	23	340
2880	10 years	28	260

Durability shall be tested in accordance with ASMT E42-69.

The sealing compound shall be supplied separately in two parts the accelerator and the base compound. The quantities of the two component packs shall be such that when mixed they would readily produce the compound ready for application, giving the best performance.

15.9 CAULKING WITH EPOXY MORTAR

Epoxy mortar consists of epoxy resin and hardener mixed with quartz sand in the proportions as recommended by the manufacturer. The epoxy mortar shall be mixed thoroughly and shall be caulked in grooves. Epoxy primer consisting of epoxy resin and hardener without quartz sand shall be mixed as per the manufactures recommendations and applied on the concrete surface prior to caulking of the epoxy compound. The top surface shall be finished smooth using trowel. It should be ensured that only such quantity is mixed which can be consumed before setting.

15.10 CAULKING WITH BITUMINOUS SEALANT

The joints shall be cleaned thoroughly and made free of debris. The bitumen based primer as per manufacturer's recommendations shall be cold applied prior to caulking with bituminous sealing compound, which shall then be hot applied. Care shall be taken that the working temperature of the sealant shall not exceed 155^0 to165^0 C since overheating of the sealant may lead to loss of its properties.

TABLE 15.1
PROPERTIES OF BITUMASTIC SEALANT

SI. No.	Characteristic	Unit	Characteristic Value
1.	Adhesion • To iron • To galvanized iron • To concrete (dry surface) • To concrete (hot humid surface)	MPa	 1.0 0.6 0.8 0.6
2.	Length development at breaking	%	>700
3.	Thermal stability	°C	110

All the sealant materials must be durable and retain their physical and mechanical characteristics and properties during its entire service life.

15.11 PROCEDURE

Before proceeding with the work, a detailed procedure shall be prepared by Contractor and submitted to the Engineer for approval. The materials shall be tested in approved test houses and each batch shall accompany with test certificates. Engineer may at his discretion, appoint his representative to witness these tests. Contractor shall also supply samples of materials to the Engineer for verification of specifications. No separate payment will be made for testing and supply of samples for testing/ verification.

All the sealant materials must be accompanied by following test certificates.

a) Chemical composition of the material
b) Compliance certificate
c) Fire-safety certificate
d) Certificate for health safety
e) Work instructions for usage

15.12 INSPECTION

15.12.1 All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer. Caulking material shall be tested for specified properties at no extra cost to NPCIL. No material exceeding the shelf life will be used and all such material shall be immediately removed from site.

15.12.2 All materials supplied by the Contractor and all works or construction performed by the Contractor and rejected – as not in conformity with the specifications and drawings shall be replaced at no extra cost to NPCIL.

15.12.3 Preliminary approvals of any materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying caulking materials and or producing finished caulking in accordance with the specifications and drawings.

15.12.4 All caulking shall be protected against damage until final acceptance by the NPCIL representative.

15.12.5 Upon completion of caulking work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area as directed by the Engineer.

16 STRUCTURAL STEEL & EMBEDDED PARTS

16.0 SCOPE

This specification covers the technical requirements for supply of all steel items required for the work as per drawings including design of connections, preparation of fabrication drawings, fabrication, inspection, testing and painting after necessary surface preparation, transporting and erection at site at desired location of:

a) Main Structural Steelwork
b) Miscellaneous structural steelwork
c) Embedded parts (Standard/ Non-standard EPs)

The specifications given below are a general guideline and reference shall be made to PC-E-160 for detailed specifications and requirements on Embedded Parts. Additional requirements for fabrication and erection of critical and important Embedded Parts which are over and above these specifications are covered in NPCIL Specification PC-E-00034.

All the works shall be carried as per approved QA procedures.

16.1 MAIN STRUCTURAL STEEL

a) Beams, girders, monorails made of rolled section and / or rolled sections with cover plates, and/or compound girders, and/or plate girders, and / or box type sections.

b) Columns made of rolled sections with or without cover plates and / or compound sections battened / laced and / or built up sections from plates with or without grinding at ends and at splice locations,

c) Roof structure such as roof trusses, purlins, bracings, etc.

d) Base plates for columns including grinding (where specified) on top of base plates and underside of column shafts.

e) Any other item of structural steel framing, though not specifically mentioned but required for the building(s).

f) Sheet metal work of minimum 0.8mm thick.

g) Floor rails of IRST 18 grade.

h) Any other structures as shown in the drawings for fabrication

i) Rail section

16.2 MISCELLANEOUS STEELWORK

a) Platforms and walkways with chequered plates / gratings.

b) Ladders with or without cages.

c) Handrails.

d) Miscellaneous equipment supports, rails for equipment movement and their associated connections.

e) Steel enclosures for equipment or electrical instrument panels, rooms etc.

f) Any other miscellaneous structures shown in the drawings for fabrication.

16.3 EMBEDDED PARTS

16.3.1 GENERAL FUNCTION AND DESCRIPTION

Embedded Parts (EPs) are any structural member, angles, channels, plates, pipe sleeves etc. cast in the concrete and used to transmit the load from attachment to concrete structure. Eps fall into following two categories.

(i) Penetration Eps are opening through the concrete structure for the passage of process piping, ducts and cables, materials and personnel.

(ii) Non penetration Eps are used primarily as a means of supporting items such as piping, cable trays, ducts, equipment and platforms to the concrete structure or for edge preparation of concrete.

Penetration and non-penetration EPs are of different types and their descriptions are given below.

(a) Plate EPS

Plate Eps are used to support piping, cable tray, ladders and equipment. A typical plate EP consists of a plate and anchorage welded to it. Component supports can directly be welded or bolted to these EPS.

(b) Pipe Sleeves

Theses EPs are used for passage of piping, cables etc. from one side of concrete structure to other side. Pipe sleeve Eps consists of a pipe and one or more puddle flanges, provided through the length of pipe for anchorage and also for improving leak tightness. These pipes are either projecting out of the concrete surface or flush with it depending upon the requirement.

(c) Anchor bolts

Anchor bolts are used for anchoring equipment like pumps, motors, heat exchangers, tanks, pipes rails for cranes and hoists etc. The threaded portion of anchor bolt projection out of the concrete shall be suitably protected by caps/ sleeves from any possible damage to the threads till the equipment is erected.

(d) Threaded sockets/ embedded inserts

Threaded socket Eps are used for anchoring the equipment like heat exchanger, motors, pumps, tanks rails for cranes, hoists etc. The threaded portion remains below the concrete face. Suitable protective plugs shall be inserted to prevent damage to the threads during construction phase.

(e) Rectangular Box type penetration EPs

These Eps are generally used for passage of a bunch of piping or cables. It consists of a rectangular box made of plates and anchorage welded to it. The anchors help in transferring the loads from the EP to concrete structure and also improve leak tightness. These EPs are either projecting out of the concrete surface or flush to it depending upon the requirement.

(f) Expansion anchors

A post-installed anchor inserted into the concrete that transfers the loads to or from the concrete by direct bearing or friction or by both. Expansion anchors may be torque controlled where the expansion is achieved by a torque acting on the screw or bolt or displacement controlled where the expansion is achieved by impact forces acting on a sleeve or plug and the expansion is controlled by the length of travel of the sleeve of the plug. These anchors are used only if

(i) EPs are missed or misplaced from actual support location with respect to reference drawings during construction. Civil contractor shall substitute these EPs with suitable anchors meeting the design intent and cost for these shall be borne by them.

(ii) Additional requirement of anchors are arisen after concreting is done on account of design change.

Approved type of expansion anchors (for seismic/ non-seismic loads) for respective systems/ buildings/ structure from approved vendors shall be used.

(g) Grouted Anchors

Grouted anchor is an anchorage system which has the anchor rod, bolt or bar grouted or dry packed into pockets left in the hardened concrete.

(h) Embedded Piping

These are the part of the process system piping, which are embedded in the concrete and are projecting out of the concrete surface for joining with other part of the system piping while erection.

(i) Special EPs

The configuration of these EPs are different from the EPs described above and are designed to suit the particular requirement. These may have stringent tolerances depending upon the requirement of the equipment.

Different EPs used in the work and covered in these specifications are given below.

a) Anchor bolts of different sizes and Plate embedded parts (EPs)
b) Pipe sleeves with circumferential baffle plates of various diameters in carbon steel and stainless steel.
c) Electrical Canister EPs
d) Drain hubs and penetration in walls/slabs which are not joined to buried piping.
e) All Hatch frames both on the receiving hatch opening and hatch blocks/beams
f) All other embedded parts as shown on drawings released for fabrication.

16.4 APPLICABLE CODES, SPECIFICATIONS

IS : 102	Ready mixed paint, brushing, and red lead. Non-setting, priming.
IS : 800	General construction in steel- Code of Practice.
IS:801	Code of practice for use of old formed light gauge steel structural steel members in general building construction.
IS: 806	Code of practice for use of steel Tubes in General Building Construction.
IS : 808	Dimensions for Hot Rolled Steel Beams, Column Channel and Angle Sections.
IS :813	Scheme of symbols for welding
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 : 875	Code of practice for Design loads, For buildings & Structures (Part 1 to 5)
IS : 919	ISO systems of limits and fits. (Parts 1& 2)
IS : 1161	Steel Tubes for Structural Purposes- Specification
IS : 1200	Method of Measurement of Building and Civil Engineering Works (Part 1 to 28).
IS: 1239	Mild steel Tubes, Tubulars and other wrought steel fittings. (Parts 1 & 2)
IS :1363	Hexagon Head Bolts, Screws and Nuts of product Grade C (Part 1 to 3).
IS:1365	Slotted counter sunk head screws.
IS : 1364	Hexagon Head Bolts, Screws and Nuts of product Grade A & B.
IS : 1367	Technical supply conditions for threaded steel fasteners (Part 1 to 20)
IS : 1477	Code of practice for painting of ferrous metals in buildings. (Part 1 & 2)
IS: 1608	Metallic materials – Tensile testing at ambient temperature.
IS :1730	Dimensions for steel plate, sheets, strips and flats for structural and general engineering purposes.
IS : 1852	Rolling and cutting tolerances for hot rolled steel products.
IS : 1893	Criteria for earthquake resistant design of structures.
IS : 1977	Low tensile Structural Steels – Specification.
IS : 1978	Line Pipe
IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
IS : 2016	Specification for Plain washers.
IS: 3502	Steel chequered Plates – specifications.
IS : 2062	Hot rolls low, medium and high tensile structural steel.
IS : 3589	Steel Pipes for water and sewage.-Specification
IS : 3757	Specification for high strength structural bolts
IS : 5372	Taper washers for channels.(ISMC)
IS : 5374	Taper washer for I beams (ISMB)
IS : 5620	Recommendation for structural design criteria for low head slide gates.
IS: 5624	Foundation Bolts – specification.
IS : 6005	Code of practice for phosphating of iron and steel.
IS: 6623	High strength structural nuts - specifications.
IS: 6533	Code of practice for design and construction of steel chimney Part 2- Structural Aspects
IS: 6639	Hexagon Bolts for steel structures – specifications.
IS :6649	Specifications for Hardened and tempered washers for high strength structural bolts and nuts.
IS : 7205	Safety code for erection of structural steel work.
IS : 7215	Tolerances for fabrication of steel structures.
IS : 8500	Structural steel - micro alloyed (medium and high strength qualities)- Specification
IS : 8629	Code of practice for protection of iron and steel structures from atmospheric corrosion (Part I-III)
IS: 9537	Conduits for electrical installations – General requirements.
IS: 10842	Evaluation procedure for Y-groove weld crack-ability test in structural steel.

IS : 11855	Guidelines for design and use of different type of rubber seals for hydraulic gates.
IS : 12843	Tolerances for erection of steel structures
SP:6(1)	ISI Hand Book for structural engineers –1, Structural Steel Section
BS : 3139	High strength friction grip bolts for structural engineering.
BS: 4395 (I)	High strength friction grip bolts and associated nuts and washers for structural engineering.
BS : 4592	Industrial type flooring and stair treads –Metal open bar gratings
BS : 4604	The use of high strength friction grip bolts in structural steel work.
AWS D1.1.	Structural Welding Code-Steel
AERB/SS/ CSE-2	Design, Fabrication and Erection of Steel Structures Important to Safety of Nuclear Facilities
ASME Sec II, Part C	Specification for Welding Rods, Electrodes and Filler Material
ASME Sec V	Non –destructive Examination.-
ASME Sec VIII, Div 1	Rules for Construction of Pressure Vessels.
ASME Sec III, Div 2	Code for concrete Reactor vessels and containments
ASME Sec IX	Qualification standard for Welding and Brazing procedure welders, brazers and welding and brazing operators
ASTM A-36	Specification for Structural Steel
ASTM A 167	Standard specification for Stainless and Heat Resisting Chromium Steel Plates, Sheet, Strip
ASTM A 262	Standard practice for Detecting Susceptibility to Intergranular attack in Austenitic Stainless Steels
ASTM A 380	Standard Practice for Cleaning and descaling Stainless Steel Plates, Equipment and Systems
ASTM A 516	Standard specification for Pressure Vessel Plates, Carbon Steel for Moderate and lower Temperature Service.
ASTM E 94	Standard Guide for Radiographic Testing
ASTM E 165	Standard test method for Liquid Penetrant Examination
ASTM E 709	Standard Guide for Magnetic Particle Examination
PC-E-160	NPCIL Specifications for Embedded parts
British Standard	EN Series carbon steel materials like EN8, EN24

The pertinent clauses and sections of the above codes, standards and specifications (latest revision), shall apply to the material, design, detailing, fabrication and inspection of the work covered by this specification as specified in the other sections of this specification.

In the event that certain requirements of this specification, applicable drawings and above standards & codes conflict with each other. The following priority shall govern in descending order.

i) Requirement given in the drawing
ii) Requirement given in specification No. PC-E-160, for EPs, PC-E-0034 for critical and

important EPs and this specification for other steel structures.

iii) Requirement given in ASME/ ASTM

iv) Requirement given in Indian standard

16.5 DRAWINGS

16.5.1 ENGINEERING DESIGN DRAWINGS

Design drawings shall show all the dimensions and if necessary, clearances of the structure, typical connection details including size & length of the weld, weld arrangement, number of bolts, size of bolts and types of bolts, size of each member, definite location of openings, to various levels, and all other information necessary to prepare drawings for fabrication and erection.

16.5.2 Fabrication Drawings

16.5.2.1 Contractor shall prepare all fabrication and erection drawings in metric units for the entire work based on the design drawings. Shop detail drawings shall show all shearing, punching, drilling, bevel cutting, bending, and all welding / bolting in complete detail. All connections and splices shall be detailed by the Contractor and clearly shown on the drawings.

EPs shall not be welded to the main reinforcement. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/ bolts, nuts, washers and other accessories complete with specification, size, length and number etc. for each erection mark and proper identification for each joint.

Bill of material shall be prepared erection mark wise, showing weight of each component part and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision. Details shown in the drawings shall be clear and legible.

16.5.2.2 Contractor shall not commence shop detailing from information on Engineering design drawings unless such drawings or part of such drawings are officially released with the stamp bearing “Released for Construction”. Contractor shall be responsible for the correctness of all shop drawings. Six (6) prints of shop drawings shall be submitted to the Engineer for scrutiny and approval. The fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by Engineer. Six (6) prints of the revised fabrication drawings shall be submitted to the Engineer for approval.

16.5.2.3 No detailed shop drawings will be accepted for examination by the Engineer unless they are complete and checked and approved by Contractor’s qualified Structural Engineer and accompanied by an erection plan showing the location of all pieces detailed.

16.5.2.4 Contractor should check for erection clearance and ensure that detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/ splices may be welded or bolted type, as specified in drawings.

16.5.2.5 Fabrication shall not be started until Contractor has received copies of such

drawings upon which Engineer has endorsed his approval. Approval by Engineer of any of the drawings shall not relieve Contractor from the responsibility for correctness of engineering, workmanship, fit of parts, details, material, errors or omissions if any and all work shown thereon. Any work done prior to approval of shop drawings will be at the Contractor's risk. The Contractor shall make such changes in the design when so directed, which are considered necessary to make the structures conform to the provisions and intent of the specifications, without any additional cost to the NPCIL. Engineer's approval shall not invalidate any claim for damages of any kind for incorrectly detailed/ fabricated steel, notwithstanding any approval of such drawings by Engineer.

16.5.2.6 Contractor shall submit design calculations, for each and every connection detail proposed by him and also for any substitution for members, desired by him and approved by the Engineer. Fabrication drawings not accompanied by calculations for the connection design are liable to be rejected.

16.5.2.7 Each lot of drawings sent by Contractor for approval shall contain a limited number of drawings and shall be in an order and manner which follows erection sequence or as required by Engineer based on priorities allocated.

16.5.2.8 Engineer will return one copy of Contractor's drawing marked with Engineer's approval/ comments. Contractor shall furnish the Engineer, Six (6) prints of all approved final drawings for field use and record purpose. Contractor shall also furnish the Engineer with one reproducible of each drawing. These reproducible shall incorporate all modifications, field changes substitutions etc. affected and shall reflect the status "as built". It should be noted that so-called sepia or similar process reproducible are not acceptable. All these reproducible are not acceptable. All these reproducible shall be submitted rolled (not folded) on the outside of regular mailing tubes.

16.5.2.9 All these drawings will remain the property of the Engineer (NPCIL). Engineer reserves the right to use them in any manner whatsoever.

16.5.2.10 Two sets of soft copies of all final approved Contractor's drawings in the form of CDs shall be furnished by the Contractor for Owner's use after incorporating the as built status.

16.5.2.11 Time consumed by the Contractor in securing approval of drawings should not be added to the time allowed for completion of contract. A period of four (4) weeks from the date of receipt of drawings by the Engineer should be anticipated for this item of procedure in the schedule.

16.6 MATERIALS

16.6.1 STEEL SUPPLY

All steel shall be procured and supplied by the Contractor, from reputed sources as approved by Engineer and shall conform to the following:

16.6.1.1 Contractor shall use materials for fabrication as specified in the approved drawings. All materials supplied by the Contractor shall be in sound condition, of recent

manufacture, free from defects such as loose mill scales, slag intrusions, laminations, pitting, flaky rust etc. The lengths/sizes of steel sections and plates shall be as supplied by the steel mills and conform to the latest issue of the relevant IS /ASME specification.

16.6.1.2 All materials required for the work shall be correlated with manufactures test certificates. In the absence of test certificates, materials shall be tested by Contractor through an approved laboratory for establishing conformance to specification's requirement at Contractor's cost, and as directed by the Engineer. All tests shall be witnessed by owner's representative.

16.6.1.3 The Contractor shall supply the mill test certificate for the materials being supplied by him.

16.6.1.4 Material supplied against these Test Certificates (TCs) should have identification stamped or stenciled on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.

16.6.1.5 The Engineer shall have the right to test random samples to prove authenticity of the test certificates produced by the Contractor at the Contractor's cost. Any material found not meeting the specification requirement would be rejected. In the absence of material specification in the drawing following guidelines are given for structural steel members:

a) Rolled sections and Bars

Rolled steel sections supplied by the Contractor shall be of following quality.

Rolled Section	: IS 2062 E 250-Quality. A
Plates below 12mm	: IS 2062 E 250-Quality. A
Plates 12mm and above	: IS 2062 E 250-Quality. B0
Plates for crane girder	: IS-2062 E 250-Quality. C

Rail section:

The Y- Groove crackability test shall be performed in accordance with IS 10842 for material of Grade E 250Quality C, having thickness 12mm and above.

b) Pipes and Pipe fittings

For pipes and pipe fittings the following standards shall apply

For pipes up to 150 mm diameter IS: 1239 Part I and II,

For pipes beyond 150m to 2000mm diameter IS: 3589.

16.7 SUBSTITUTIONS

Whenever the Contractor desires to substitute structural members, shown on the drawings, due to non-availability of requisite materials, such substitutions shall be made only after authorization in writing by the Engineer.

Engineer may also direct to make substitution, when he considers such substitution is necessary.

16.8 FABRICATION OF STRUCTURAL STEEL

16.8.1 GENERAL

All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best-approved method of fabrication. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in American Institute of Steel Construction Manual and IS Codes shall generally be followed unless otherwise directed/ approved. For EPs specific requirements given in para titled 'EMBEDDED PARTS' and 'PAINTING' of this specification shall be followed in case found to be in variation with other clauses of this section. Materials at the shop shall be kept clean and protected from weather. In addition

a) All care should be taken to avoid undue welding distortions.
b) Complete layout shall be prepared and got approved by the Engineer before actual fabrications are started. If needed mock-ups may also be prepared.
c) All fit ups shall be got approved from the Engineer.
d) Standard tolerances as per relevant IS specifications shall be followed in case they are not provided in relevant drawings and specifications.

16.8.2 ELECTRODES

All Electrodes and welding shall be of low hydrogen type conforming to ASME Sec II Part C. Brands approved by NPCIL shall only be used. The bidders shall submit the list of venders and seek approval of NPCIL.

16.8.3 CONNECTIONS

16.8.3.1 All connections shall be designed (In case these are to be designed by the contractor) for forces indicated on the design drawings. The contractor shall be responsible for selection of standard connections from AISC, "Manual of Steel Construction" unless specified in drawings. Where standard joints are not available, contractor shall design connections and shall get Engineer's approval prior to fabrication.

16.8.3.2 Connections shall be effected either by welding or bolting or as specified on the drawings. Type and quality of weld/bolts shall be in accordance with relevant IS Codes and as specified in the drawings.

16.8.3.3 Where necessary, tapered washers, flat washers or spring washers shall be used with bolts. The length of the bolt shall be such that at least one thread of bolt projects

beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the thread pitch.

16.8.3.4 In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, even if a longer grip bolt has to be used for this purpose.

16.8.3.5 Wherever applicable, all connections and splices shall be designed for full strength of members or loads indicated unless otherwise approved. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice. Unless otherwise specified, beam end connections shall be designed for 60% of the shear capacity of rolled sections and 80% of shear capacity for built-up sections plus additional axial forces, if any.

16.8.3.6 All members likely to collect rainwater shall have drain holes provided.

16.8.3.7 Shop connections shall be generally welded. Field connections shall be made with bolts or HSFG bolts or welding as specified on the drawings.

16.8.3.8 In general, splice joints are not permitted except where standard length of the section under consideration is not sufficient to build the full length of the member. However, under exceptional condition, not more than one shop splice shall be permitted to make up the full length of a member with prior approval of Engineer at no extra cost to NPCIL. Shop splices to make the full member lengths shall be of full penetration butt-welded type and radio-graphically tested.

16.8.4 STRAIGHTENING

16.8.4.1 Rolled material, before being worked, shall be straightened, unless otherwise required/specified. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or levelling rolls and structural shapes by the use of mechanical or hydraulic bar/section straightening machines. Heating or forging shall not be resorted to without the prior approval of the Engineer in writing. In case of site fabrication, the Engineer shall approve the straightening methods in writing before commencing the work.

16.8.4.2 Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends, structural members shall be submitted for inspection and approval of Engineer.

16.8.5 CUTTING

16.8.5.1 Cutting may be done by shearing, chopping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12-mm. Sheared

or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

16.8.5.2 Hand flame cutting shall be undertaken, only if so permitted by the Engineer and shall only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight, for minimum 2mm in depth to remove the oxide layer.

16.8.5.3 Edges of flange cover plates and plates used to form any sections shall be ground smooth/planed.

16.8.6 PUNCHING AND DRILLING

16.8.6.1 Holes for all connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected, such parts shall be first assembled, tightly clamped together and drilled through. Holes in secondary members such as purlins, girts, lacing bars etc. may be punched full size through material not over 12 mm thick. Holes should be clean cut, without burr or ragged edges.

16.8.6.2 ub-punching may be permitted before assemble, provided the holes are punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16 mm.

16.8.6.3 When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

16.8.6.4 Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to HB tolerance specified in IS: 919.

16.8.6.5 Where reamed members are taken apart for transporting or handling the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

16.8.6.6 Holes may be required to be drilled by the Contractor at site for installing equipment or steel furnished by other agencies. The information for this will be supplied to the Contractor by the Engineer before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

16.8.7 ROLLING AND FORMING

Plates, channels, RSJ, etc., for circular bins, crane girders, gantry girders etc shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field. In the case of stainless steel materials while rolling care shall be taken to avoid direct contract of MS/CS rollers with SS material in view of iron contamination to SS materials. A detailed rolling & forming procedure shall be

prepared by the contractor and Engineer approval shall be obtained prior to execution.

16.8.8 GRINDING

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plates shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap), unless mentioned and approved otherwise. All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However the underside of base plate bearing on cement grout need not be ground smooth.

16.9 GRATINGS

All gratings shown and/or listed in the drawings shall be fabricated as a complete unit as detailed or as necessary for connections to structural steel framing. The gratings shall be capable of sustaining a safe live load of 500 kg/sq. metre of plan area unless otherwise specified on the Engineer's design drawings. Treads and landings shall be suitable for the prescribed loading and be furnished complete with a one-piece standard non-slip abrasive nosing of approved type.

16.9.1 ELECTROFORGED GRATINGS

Electro forged Gratings shall be of custom fabricated/ cut to size in shapes (rectangular/ circular etc.) as required with serrated bearing bars. Gratings shall be fixed at all elevations with clamps, siddle clip & slotted clamps including drilling, providing and fixing screws. It shall be hot dip galvanized as per IS 4759 but in no case it shall be lesser than 610GSM. Wherever, due to functional requirements Galvanizing is not acceptable the grating shall be painted with high build epoxy with minimum DFT of 200 micron (excluding primer) over 75 micron zinc silicate primer etc. The gratings shall be capable of sustaining a safe live load of 500 kg/sq. meter (unless specified otherwise) of plan area. Treads and landings shall be suitable for the prescribed loading and be furnished complete with a one-piece standard non-slip abrasive nosing of approved type. The Contractor shall submit the design and fabrication drawing to NPCIL for approval prior to procurement of gratings.

16.10 HANDRAILS

Handrails shall be provided on open sides of platform, stairways and around all openings as shown in drawings. Handrails shall be of SS/mild steel pipe as specified in the drawings of flush welded construction and ground smooth. Unless specified otherwise the handrail shall be fabricated using 32mm nominal bore medium class pipe provided with double rail, top rail about 1 meter above platform / walkway level and the intermediate rail 450 mm below top rail and pipe posts spaced not more than 1.5 metres apart and 150 mm high 6mm thick toe plate. All MS handrails shall be painted as per requirement given in the drawings.

Smooth uniform curves and bends shall be provided at stair returns and also where so

ever required /specified. Posts connected to curb plates shall have a neat closure at the bottom and a 6mm thick plate nearly welded to posts for attachments to curb plate/ toe guards. All necessary fittings including inner dowels at splices, brackets, bolts, bends, flanges and chains, shoes for removable type handrails where required shall be furnished by the Contractor. Open ends of all the pipe posts shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

16.11 CHEQUERED PLATE

Chequered plates used shall be minimum 6mm thick or as indicated in the drawings and shall be capable of carrying a minimum live load of 500 kg/sq.m unless otherwise specified in the design drawings. Chequered plate shall be fixed by 8mm diameter cadmium plated M.S. screws with countersunk heads at a maximum spacing of 400mm. Members supporting the chequered plate shall have matching holes tapped in them. Chequered plates may also be required to be welded to the structural steel framing. The decision in this regard will be given by the Engineer wherever required/ specified.

Thickness of zinc coating shall be as per IS: 4759 for structural steel plates, angles, channels etc. and as per IS: 4736 for pipe sleeves.

16.12 WELDING

16.12.1GENERAL

16.12.1.1 Welding procedure specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done in accordance with the requirements of ASME Sec IX, or AWS D 1.1 as and where specified. Welders employed shall also be qualified as per above standards prior to taking up fabrication.

Following pre-qualified welding process shall be employed for fabrication, erection and repair by:

a) Submerged Arc Welding (SAW).
b) Shield Metal Arc Welding (SMAW).
c) Gas Metal Arc Welding (GMAW).
d) Gas Tungsten Arc Welding (GTAW)

16.12.1.2 All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

16.12.1.3 50mm on either side of the surfaces on which weld metal is to be deposited shall be smooth, uniform, free from fins, tears burrs cracks and absolutely free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

16.12.1.4 Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth & regular surface free from cracks & notches. Flame cut material above 50mm thick shall be pre-heated to 100°C prior to flame cutting.

16.12.1.5 All weld fit-up shall comply with tolerances specified in the design drawing. The parts to be joined by fillet welds shall be brought into close contact as practicable. The root gap in no event shall be greater than 3 mm for SMAW process and 1.5mm for SAW process. If the separation is greater than 1.6mm the leg of the fillet weld shall be increased by the amount of root opening. This shall apply only in the case of continuous welds. Abutting parts to be butt-welded shall be carefully aligned and correct root gap shall be maintained throughout the weld operation. The fit up of joints at contact surfaces that are not completely sealed by welds shall be close enough to exclude water entry after painting. The separation between laying surfaces of lap joint and butt joints with backing plate shall not exceed 1.5mm. Abutting parts to be butt-welded shall be carefully aligned and the correct root gap maintained throughout the welding operation. Misalignments greater than 25% of the thickness of the thinner plates or 3mm, whichever is smaller, shall be corrected and in making the correction, the parts shall not be drawn into a slope sharper than 2 degrees.

16.12.1.6 All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed.

16.12.1.7 Welding of temporary attachment/fixtures to retain fit up is allowed in case the parts have a nominal thickness of at least 6mm. Temporary attachments are welded to at the distance of at least 30 mm from the weld seam for construction of CS and least 60mm for welding austenitic steel. Welding of temporary attachments/fixtures into the joint slot is not allowed. All temporary fixtures to be removed after welding by grinding them to weaken the welded portion and hammering thereafter, followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/defect at the point of fixture temporary weld.

16.12.1.8 It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings.

16.12.1.9 Non-flatness of the facing sheets being assembled into the subassemblies in the longitudinal and transverse direction is allowed within 10mm for 1m of the length.

16.12.1.10 During the installation of the structural steel members care shall be taken to prevent damage of the sheets and of the welding seams. The work shall be positioned for

flat welding wherever practicable and overhead weld shall be avoided as far as possible.

16.12.1.11 In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

16.12.1.12 Welding shall not be done when the surface of the members are wet or exposed to rain or high wind velocities unless the welding operator and the work are properly protected. In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as shown in the following table unless otherwise specified in the drawing.

Material thickness of Thicker part joined (mm)	Minimum size of fillet weld (leg dimension of fillet weld) (mm)
Up to 6	3
Over 6 to 12	5
Over 12 to 18	6
Over 18 to 36	8
Over 36 to 56	10
Over 56 to 150	12
Over 150	16

16.12.1.13 Fillet welds 5 mm or larger in size for SMAW and 10mm for SAW shall be made with two or more passes. Welding rods shall be 3.15 in diameter maximum for root passes, and 4mm and above in diameter for subsequent passes. Complete penetration butt weld shall be terminated at the ends of the joint in a manner that will insure their soundness. Where abutting parts are 20mm or more in thickness, suitable run-on and run-off plates with similar edge preparation and having a width not less than the thickness of the thicker part shall be used. These extension pieces shall be removed after completion of weld and the end of the weld made smooth and flush with the abutting parts.

16.12.1.14 In case of full penetration butt welds without backing , root weld shall be back gouged to sound metal before second side welding for complete fusion throughout the entire cross section. However, in case of square butt welds done in flat position from both sides and with thickness of parts joined less than 8mm and root opening not less than half the thickness of the thinner part, gouging can be dispensed with, if approved by the engineer.

16.12.1.15 All welded shop splices in each component part of covered plate beam or built up member shall be made before the component part is welded to other parts of the member. Long girders or girder section may be made by welding sub assemblies

each made in accordance as explained above. When making these sub assembly splices, whether in the shop or field, the welding sequence should be reasonably balanced between web and flange welds. Where weld reinforcement interferes with the proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

16.12.1.16 Preheating for welding of steel shall conform to ASME Section VIII Div 1

16.12.1.17 Post weld heat treatment (PWHT) shall be carried out if the weld size is more than 50mm, unless specified otherwise. The procedure for PWHT shall conform to ASME Section VIII Div 1. No stress relief using oxyacetylene flame is permitted.

16.12.1.18 In assembling & joining parts of a structure or a built-up members and in reinforcing parts to members, the procedure and sequence shall be such as to minimize distortion and shrinkage. The fabricator shall prepare a welding sequence for a member or structure which in conjunction with WPS and overall fabrication method, will produce members or structure meeting the quality requirement specified. The welding sequence and distortion control programme shall be submitted to Engineer for comments and information before start of welding such program shall include, besides other appropriate details, full particulars in regard to the following:

a) Proposed pre-bending in components such as flanges and flange cover plates and pre-setting of joints to offset expected distortion.
b) Make up of sub-assemblies proposed to be welded before incorporation in final assembly.
c) Proposed joint forms, classification of wire and flux or covered electrodes, welding process including fit up and welding sequence with directions in which freedom of movement is to be allowed.
d) Proposed number, spacing and type of storage backs and details of jigs and fixtures for maintaining proper fit up and alignment during welding.
e) Any other special features like assembling similar members back to back or stress relieving procedure.
f) If so desired by the Engineer, mock up welding shall be carried out at Contractor’s cost to establish the efficiency of the proposed programme, with any modification suggested by the Engineer in limiting distortion or /and residual stress to acceptable levels.
g) For sections made of rolled sections with cover plates, the ends of the plate shall be seal welded or alternatively flange cover plate terminated 25mm short of the full length and welded across to the beam for proper end sealing and/or as directed by the Engineer.

16.12.1.19 Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material. All welds shall be stamped/identified with

System/Joint No/Welder punch etc. as per approved procedure at a distance of 30-35 mm from the weld seam.

16.12.2 WELDING CONSUMABLES

16.12.2.1 Electrodes, filler wires and flux used for welding shall be from approved manufacturers/Suppliers. When requested by the engineer, the contractor shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage & amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

16.12.2.2 Electrodes, filler wire and consumables shall conform to the requirements of ASME Sec. II Part C.

16.12.2.3 Only low hydrogen electrodes to AWS E7018 shall be used for welding for all Carbon Steel material. Whenever high tensile welds are required to be employed than E-8018 electrode are to be used of approved make. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. SMAW electrodes shall be properly stored. Before welding, the electrodes shall de dried in a holding oven as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

16.12.2.4 The filler wire and flux combination for submerged arc welding shall conform to the requirements of ASME Section II, Part C. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that of base material specification. The flux used for SAW process shall be dry and free of contamination from dirt, mill scale or foreign material. The flux purchased in packages shall be stored in dry place. Flux shall be dried in case of damaged package at a temperature of 260° C for 1 hour prior to welding operation. Flux shall be placed in dispensing system immediately upon opening a package.

16.12.2.5 Welding plants and accessories shall be of adequate capacity and shall satisfy appropriate standards and be of the approved make and quality. Proper safety rules shall be followed and adequate means to measure the current shall be provided.

16.12.2.6 Wet magnetic particle inspection in accordance with ASME Sec. V may be performed.

16.12.2.7 For other magnetic materials dry power magnetic particle inspection in accordance with ASME Sec V.

16.12.3 WELD REPAIR

Whenever weld repair is required, Contractor shall give prior intimation to the Engineer and permission before the repairing is taken up. When a defect is detected in a weld, it shall be removed by cutting/grinding and smooth blending of the area with parent metal

without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure/welder and stage inspection as per the original weld. Correction of defect in the same portion of the weld shall not be allowed more than two (2) times. Portion of the welding seams, which have been subjected to repair, must be indicated in the weld inspection reports.

16.13 ERECTION

16.13.1 GENERAL

16.13.1.1 The Contractor shall supply all erection bolts, permanent bolts and electrodes as required for the job. At all times the Contractor shall be responsible for the safety and protection of fabricated material, from loss or damage of any nature until the completion of erection work.

16.13.1.2 Structural steel work will involve the erection of columns, beams, bracing, crane girders, purlins, trusses, monorails, ladders, platforms, gratings, chequered plates etc.

16.13.1.3 The Contractor shall complete all preliminary works at site, including post concrete survey wherever required well before the arrival of fabricated structural steel, such as keeping in readiness electrical winches, mobile cranes, gin poles, compressors, all tools and tackles, welding sets, torque wrenches, impact wrenches, etc., as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of fabricated steel at site.

16.13.1.4 The Contractor shall arrange for such quantum of erection equipment, supervision staff, labour and other arrangements so as to carry out the work efficiently. The equipment and services provided by Contractor shall include but not be limited to, the supply of labour, transport vehicles, crane derricks, gin poles, winches, welding equipment and tools, compressed air if required, blocking, scaffolding, locked storage for tools, welding rods, positioners, cables etc required for site fabrication assembly and erection of the structure. If found necessary the Contractor shall also provide at hisown cost arrangements for inspection and testing of material used in erection. He shall satisfy the Engineer regarding arrangements for various types of work to be undertaken by him.

16.13.1.5 No dragging of fabricated structural steel shall be permitted.

16.13.1.6 All fabricated structural steel shall be stored 150mm above ground on suitable packing, to avoid damage during the monsoon. Steel shall be stored in the order of erection with erection/identification marks visible. Storage areas shall be prepared and maintained by the Contractor. Any steel stored near excavations shall be removed immediately to a safe distance to avoid burial under debris.

16.13.1.7 The Contractor shall protect all existing plants, embedded parts, all permanent and temporary structures, piping, conduits, equipment and facilities against damage during erection. The Contractor shall perform his work in a manner, which in no

way endangers the operations of any existing plant or structures or hinders other construction activities.

16.13.1.8 The Contractor shall arrange at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after the completion of the job. The Contractor shall also provide necessary passageways, fences, safety belts, helmets, safety shoes, lights and other fittings to the satisfaction of the Engineer and for protection of his men and materials.

16.13.1.9 All structures shall be erected as shown in drawings. The Contractor shall carry out all erection work in the sequence required/ approved by the Engineer. The methods of erection and complete erection scheme shall be subject to the approval of the Engineer and shall be modified wherever required by the Engineer. This, however, will not relieve the Contractor of the responsibility for safe and expeditious completion of the work, its quality and accuracy.

16.13.1.10 Drifts should be used only for drawing the members into position and must not be used to such an extent so as to destroy the holes. Drifts of a larger size than the nominal diameter of the hole shall not be allowed. Any damaged holes or burrs must be rectified to the satisfaction of the Engineer. Correction of minor misfits and reasonable amount of reaming, if any, shall be considered as a part of erection. Any error in shop work, which prevents proper fit even after a moderate amount of reaming and slight chipping or cutting shall be immediately reported to the Engineer. The Contractor's work shall also include straightening and repairing of materials slightly damaged and drilling some holes in members where required. This is deemed to have been included in the unit rate quoted and nothing extra shall be payable for the above operations. Non Conformance Report (NCR) shall be raised and got approved for all repairs and modification required.

16.13.1.11 In case of any faulty erection, all such dismantling and re-erection required will be at the Contractor's cost. Shim stock of mild steel plates, required for erection will be set, leveled and prepared for grouting / dry packing.

16.13.1.12 Where flat bearing beams occur, bearing plates shall be set, levelled and prepared for grouting/dry packing.

16.13.1.13 Structural Steel frames shall be erected plumb and true to tolerance indicated in the relevant clause. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracing shall be introduced wherever necessary to take care of all loads to which the structures may be subjected including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety. Proper size steel cables, slings etc shall be used to avoid any damage due to accidents.

16.13.1.14 As erection progresses, the work shall be securely bolted to take care of all dead load, wind and erection stresses. No final welding or bolting shall be done until the structure has been properly aligned and approved by the Engineer.

16.13.2 CODE

Unless specified in the relevant drawing and specification, all erection work shall be carried out in accordance with the latest edition of Indian Standard Code of Practice for use of Structural Steel in General Building Construction IS-800 & AISC code wherever applicable.

16.14 ANCHOR BOLTS & FOUNDATIONS

16.14.1 The Contractor shall carefully check the location and layout of anchor bolts embedded in foundation constructed to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Engineer.

16.14.2 Anchor bolts shall be provided with two nuts of approved grade of materials as per relevant IS or ASTM standard codes on upper threaded portion, one of which may be used for levelling the column base to the required elevation and one will be a lock nut. All shim stock, required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good MS plates and shall be supplied by the Contractor at his cost .Required no of washers shall also be provided by the contractor at his cost.

16.14.3 Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. The Contractor shall carry out all grouting under column base plates or beam bearing plates, unless the grouting is specifically excluded from the scope of work.

16.14.4 HIGH STRENGTH FRICTION GRIP BOLTING

16.14.4.1 High strength friction grip bolts and nuts shall conform to IS: 3757 and/or BS: 3139/ or ASTM A325.

16.14.4.2 Installation of high strength friction grip bolts in joinrs shall comply with IS : 4000 and / or BS : 3294 and or specification for structural joints using ASTM A 325 or A490 Bolts by Research council on Rivetted and Bolted Structural Joints.

16.14.4.3 The diameter of the bolt holes will not be more than 1.5 mm larger than the nominal diameter of the bolt. All contact surfaces in a connection including those associated with the bolt heads, nuts and washers shall be free of scales, burs, dirt and other foreign matters tending to inhibit uniform sealing of the joint components. However, tight mill scale and the light residual oil coating on bolts, nuts and washers need not be removed.

16.14.4.4 All fasteners in a joint shall be tightened to a tension equal to greater than the specified proof load .either by the calibrated wrench method or the turn –of- nut method.

16.14.4.5 Tightening may be achieved by use of pneumatic powered impact winches , long

handled manual torque wrenches with or without torque multiplier or electric wrenches . A hardened washer shall be placed under the element being turned. Bolts shall be tightened at the most rigid portion of the joint, proceeding towards the free edges.

16.14.4.6 When using the calibrated wrench method, adjustable power impact wrenches and manual torque wrenches shall be calibrated to induce the bolt tension of 5% in excess of the proof load values, for each size of bolt to be used in the installation. Every wrench shall be calibrated by having it tighten a minimum three bolts of the same diameter, in a hydraulic tension measuring device. Calibration shall be repeated whenever a wrench is required to tighten a different size bolt or at least once each working day if there is no change in the bolt size. Impact wrenches shall be set so as to stall or cut at the torque effort corresponding to the prescribed fasteners tension. When manual torque wrenches are used the torque indication corresponding to the calibrating tension shall be determined and taken as the job standard. Torque measurement shall be read while the turned element is in the tightening motion. As subsequent tightening of bolts in particular assembly is liable to loosen bolts already tightened, all bolts must be 'Touched up'.

16.14.4.7 If finger tight condition is used as a string point an extra full turn shall be taken to correspond to one half turn from the snug- tight position.

16.14.4.8 Load indicating bolts or load indicating washers may be used if so approved by the engineer in writing.

16.14.4.9 Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method and type of bolt used .

16.15 ERECTION PROCEDURES

16.15.1 The structures shall be erected by assembling in sections on the ground and hoisting successive sections into place, or they may be built up in place by individual members at the option of the Contractor. The staging in different sections already erected shall be self-sufficient in stability for all conditions or stresses including those caused by wind. If erected by assembling in sections, not less than 50% of all bolting in place shall be done in each section before starting another section.

16.15.2 All bolts shall be drawn up tight but not to such a degree as to endanger the strength of the bolts and nuts shall be locked in place with lock nuts. Only wrenches approved by the Engineer shall be used on the work and the use of any wrench, which may deform the nut, will not be permitted. At least ten percent of the bolts in each connection as directed by Engineer shall be tested for tightness by calibrated wrenches or other approved methods free of charges. If any bolt in any connection is found to be not sufficiently tightened, all bolts in that connection shall be re-tightened and tested again without claiming any extra.

16.15.3 The Contractor shall take all precautions for the safety of labourers at the time of erection. Safety belts shall be provided to workers while working at all levels for the

erection of tower. The erected structure shall be well secured and protected at the close of the day to avoid any damage to the structure and workman.

16.16 TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel. The tolerances for fabrication of structural steel shall be as per IS: 7215. Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances of process technologists//suppliers which will be indicated in the drawing.

16.16.1 Columns

Deviation of column axes at foundation top level with respect to true axes

(a)	In longitudinal direction	:	± 5 mm
(b)	In lateral direction	:	± 5 mm

16.16.2 Deviation in the level of bearing surface of columns at foundation top w.r.t. true level : ± 5 mm

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:	
(a)For columns up to and including15 meters in height:	± 1/1000 of column height inmm
(b)For columns exceeding 15 meters in height:	± 1/1000 of column height inmm or ± 20 mm whichever isless
Deviation in straightness in longitudinal and transverse planes of column at any point along the height:	± 1/1000 of column ht in mm or ± 10 mm. whichever is less.
Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance.	± 10 mm
Deviation in any bearing or seating level with respect to true level	± 5 mm
Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the building	± 10 mm

16.16.3 Connection of Members

Beams up to 600 mm in depth - 1.5 mm

Beams over 600 mm in depth - 1.5mm every 600mm depth to a max. of 3mm.

Where abutting parts are to be joined by bolting through cleats or end plates, the connection requires closer tolerance.

Permissible deviation from the squareness of the end is
For Beams - 1 mm per 600 mm of depth up to a max. of 1.5 mm.

16.16.4 **Depth of Members**

Acceptable deviation from the specified overall depth is
For depth of 900 mm and under - +/- 3 mm
For depth over 900 mm and under 1800 mm- +/- 5 mm
For depth of 1800 mm and over - +8 & - 5 mm

16.16.5 **Trusses and Beams**

Shift at the centre of span of top : ± 1/250 of height of truss in mm

Chord member with respect to the : ± 15 mm whichever is less
Vertical plane passing through the centre of bottom chord.

Lateral shift of top chord of truss at the : ± 1/1500 of span of truss in mm

Centre of span from the vertical plane or : ± 15 mm whichever is less
passing through the centre of supports of the truss.

Lateral shift in location of truss from its : ± 10 mm
true vertical position

Lateral shift in location of purlin true
position : ± 5 mm

Deviation in difference of bearing : i) ±20 mm for trusses
levels of trusses or beams from ii) for beams :
the true difference Depth < 1800 mm : ±6mm
Depth > 1800 mm : ±10 mm

Deviation in sag in chords and diagonals : 1/1500 of length in mm
of truss between node points or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc.: 1/1000 of span in mm
in the horizontal plane subject to a max. of 10 mm

16.16.6 **Crane Gantry Girders & Rails**

Shift in the centre line of crane rail with : ± 5 mm
respect to centre line of web of crane gantry girder

Shift in plan of alignment of crane rail with : ± 5 mm

respect to true axis of crane rail at any point

Difference in alignment of crane rail in plan : ± 1 mm
measured between any two points 2 metres apart along rail

Deviation in crane track with respect to true gauge

(a) For track gauges upto and including 15 metres	:	± 5 mm
(b) For track gauges more than 15 metres	:	± [5 + 0.25 (S-15)] where S in metres is true gauge

Deviation in the crane rail level at any point from true level : 1/1200 of the gauge distance or ± 10mm whichever is less

Difference in the crane rail actual levels between any two points 2 metres apart along the rail length : ± 2 mm

Difference in levels between crane track rails at

(a) Supports of crane girders	:	± 15 mm
(b) Mid span of crane girders	:	± 20 mm

Relative shift of crane rail surfaces at a joint in plan and elevation : 2 mm subject to grinding of surfaces for smooth transition

Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm : 1/1000 of track gauge S in mm subject to maximum of 20 mm

16.16.7 **Towers:**

Out of plumbness (verticality) from the true vertical axis : 1/1000 of the height of the chimney or tower in mm .

16.17 MARKING OF MEMBERS

16.17.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The match mark shall be punched on both sides of the member and the erection mark on the face of the member. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

16.17.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

16.17.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

16.17.4 In case of embedded parts, identification mark shall be visible on the exposed surface after embedding in place.

16.18 STORAGE

16.18.1 The Contractor shall have proper arrangements for storage. He shall identify the storage area where raised platform will be constructed by him. The materials will be identified area-wise and quantity-wise with proper identification marks.

16.18.2 Covered storage (Storage of fabricated materials): The Contractor shall make storage arrangements category-wise for storing fabricated materials and these materials shall be available for erection whenever called for. Fabricated materials should be stored separately according to different categories viz. embedded parts, pipe sleeves, angle frames, gratings and fabricated structural shapes. All the above materials when stacked should have proper access for inspection either by the Engineer or his authorized representatives.. The fabricated materials should be properly identified by giving identification marks. Similar precautions shall be taken to prevent the above material from rusting or any damage during the storage. Any fabricated EPs/material damaged/rusted during storage shall be rectified/repaired at Contractor's own cost.

16.19 INSPECTION, TESTING & REPORTS

16.19.1 Contractor shall give due notice to Engineer in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for Engineer's approval/inspection. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by Engineer if it fails to be in proper condition or has fabrication inaccuracies which prevents proper assembly. No material shall be painted or dispatched to site without the inspection and approval by Engineer unless such inspection is waived in writing by the Engineer.

16.19.2 Shop inspection by Engineer or his authorized representative or submission of test certificates and acceptance thereof by Engineer shall not relieve Contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the Engineer may make because of defective or unsatisfactory material or workmanship.

16.19.3 Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. Contractor's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

16.19.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to Engineer. Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint .All welds shall be inspected for flaws by the method described under the relevant Clause The inspection and testing on structural steel members shall be as set forth below:

16.20 MATERIAL TESTING

16.20.1 All materials conforming to a particular Indian/ASTM or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating the required tests have been carried out as per specification at the source as acceptable. In case these are not available, then the Contractor at his cost shall perform these tests.

16.20.2 Engineer has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing will be borne by the Engineer.

16.20.3 The Contractor shall maintain records of all inspection and tests, which shall be made freely available to the Engineer and shall be submitted to the Engineer at completion of each stage of work.

16.20.4 If mill test reports are not available for any steel materials, the same shall be got tested by Contractor to Engineer's satisfaction to demonstrate conformity with the relevant specification at his own cost.

16.20.5 The tests are restricted to as per Indian/ASTM or any other standard for a particular material as required by such standard. If any additional tests are required to be done actual expenses shall be reimbursable.

16.21 INSPECTION OF WELDS

The following methods are used for the quality control of welded joints. All weld shall be grinded and thoroughly cleaned before taking up the inspection

16.21.1 Visual Inspection

Visual inspection shall be performed prior to and during and after non-destructive testing. The completed welds should be checked for correct size and profile. All weld surfaces shall be free from slag, creators, abrupt ridges and vallies, arc strikes. Prior to fabrication proper included angle, route opening, route face, alignment and cleanness of joint shall be checked and ensured. All weld shall be visually inspected to ensure the welding performed are within the acceptable limits.

16.21.2 Magnetic Particle Test (MPT)

Wherever specified, all MPT shall be as per ASTM- E709. Defects if found, shall be repaired and retested.

16.21.3 Dye Penetrate Inspection

MPT may be substituted by Dye Penetrate Inspection where the former is not feasible due to configuration. All surfaces of the welds to be inspected by DPT shall be free from scale, flux, ridges etc. The testing should be in accordance with ASTM-E165. Defects, if found, shall be repaired and retested. The cost of demagnetizing after testing shall also deemed to be included in the quoted rates of the Contractor.

16.21.4 Radio-graphic Examination

Wherever specified, Full penetration butt welds shall be radio-graphed or spot radiographed as shown in drawings /QA plans in accordance with ASTM: E-94 and as specified.

16.21.5 Ultrasonic Testing

Wherever built up sections for crane runways girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing as per ASME, Sec-V, Article 5.

16.21.6 Acceptance Standard

The acceptable standards for weld inspection shall be as per ASME Sec VIII - Div I.

16.22 DIMENSIONS, WORKMANSHIP AND CLEANLINESS

All the fabricated embedded parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved Contractor's shop drawings and/or Engineer's drawings.'

16.22.1 The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.

16.22.2 Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick or as per the material specification shall be carried out for the soundness of material.

16.22.3 The cut edges of plates more than 25 mm for fillet weld, butt welds, and the plates used for tension flanges and webs -100 % MPT / DPT shall be carried out.

16.22.4 Welding shall be carried out as per approved WPS and QWS by qualified welders.

16.22.5 Macro etch test on welds shall be carried out 1 per structures for built up girders, columns and other heavy structures for penetration.

16.22.6 For 100% weld length, MPT / DPT on root & final pass for thickness equal to or greater than 25mm for butt welds.

16.22.7 For 100% weld length, RT shall be carried out for thickness equal to greater than 32 mm butt welds.

16.22.8 For 100% weld length RT for butt welds of rolled sections having a depth greater than 600 mm shall be carried out.

16.22.9 Minimum 10% of Fillet welds length, for either plate thickness is up to and inclusive 25 mm or fillet size is less than 10 mm (inclusive 10mm), root & final pass MPT /DPT shall be carried out.

16.22.10 On 100 % weld length, MPT/DPT shall be carried out on root & final pass, for either plate thickness greater than 25mm or fillet welds is more than 10 mm size.

16.22.11 Dimensions of all the assemblies and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS 7215.

16.22.12 For full penetration welds, DPT shall be carried out after back gouging before second side welding.100% MPT shall be carried out on low alloy steel, flame cut edges for thickness greater than 12mm.

16.22.13 Wherever built up sections for crane runways girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing as per ASME, Sec-V, Article 5,

16.22.14 The contractor shall maintain records of all inspection and tests, which shall be made freely available to the Engineer or his authorized representative and shall be submitted to the Engineer at completion of each stage of work.

16.22.15 The contractor shall ascertain that materials conforming to the requirements of this specification only are used.

16.22.16 The contractor shall check that the welding procedures (including the electrodes, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

No	Type of defect	Acceptance criteria	Remarks
1	Cracks	Not acceptable (NA)	
2	Incomplete or lack of fusion	Not acceptable (NA)	
3	Misalignment of butt welds	0.25 x T maximum of 3 mm	T: Thickness of thinner plate
4	Reinforcement	Max reinforcement of 2 mm for t < 10 mm 3 mm for t > 10mm < 15 mm. 4 mm for 15 mm and greater	
5	Undercut	0.25 mm deep max	
6	Sharp edges	Min radius of 2 mm	

16.22.17 **Inspection of Test Failure**

In the event of any failure of structural, steel members to meet inspection or test requirements, the Contractor shall notify the Engineer or his authorised representative.

A Non Conformance Report (NCR) has to be made and got approved from the Engineer or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by Engineer. Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer or his authorized representative, for three years from the date of completion of the contract.

16.23 EMBEDDED PARTS

16.23.1 General

The details furnished below are in addition to general requirements of material supply, fabrication, inspection, testing etc specified in the earlier clauses of this specification. In general, reference shall be made to PC-E-160 for detailed specifications and requirements on Embedded Parts.

16.23.2 Material

Contractor shall supply/ use materials for fabrication as specified in the drawings. In the absence of material specification in the drawing, following guide lines are given.

Design	Spec	Remarks
Plates for pipe sleeves of wall thickness less than 20 mm	IS-2062Grade E-250, Quality –B0	
Flanges and plate EP's and threaded fasteners of 20 mm thk/ dia and more	IS-2062, Grade E-250, Quality – B0	
C.S Pipes up to 150 mm NB	1S-1239 Heavy Grade	
C.S. Pipes of sizes 200 mm NB and above	IS-3589 Grade FE 410	
Stainless Plates	ASTM-A-240 type 304L	IGC tested
Stainless pipes	ASTM-A-312 type 304L	Seamless or seam welded by automatic or manual process. Inspection as per specification.

Rolled sections and Bars
Rolled steel sections supplied by the Contractor shall be of following quality.
Rolled Section : IS 2062 E 250-Quality. A
Plates below 12mm : IS 2062 E 250-Quality. A
Plates above 12mm : IS 2062 E 250-Quality. B

16.23.3 Electrodes
All electrodes and welding wire shall be low hydrogen type conforming to ASME Sec II Part C. Brands approved by NPCIL shall only be used.

16.23.4 Material test certificate shall be in original.

16.23.5 Material supplied against these TC's should have identification stamped or stenciled on them which can be correlated with the TC's

16.23.6 All such identification markings shall be authenticated by the inspection agency which has inspected and approved the material.

16.23.7 The contractor shall furnish to the Engineer duplicate copies of all purchase order copies covering the material ordered by him for this project and also test reports.

16.23.8 The Engineer shall have the right to test random samples to prove authenticity of the test certificates produced by the Contractor.

16.23.9 Fabrication of EPs

Fabrication of EPs shall be done as per the relevant drawings and specification to avoid any possible damage to the threading on the anchor bolts before erection of the equipment, suitable protective plugs are inserted. In some cases, internally threaded sockets are embedded with top of the socket kept flush with the concrete face.

16.23.10 Welding

All welding procedures and welder performance qualification shall be carried out as per ASME Section IX supplemented by ASME Sec. VIII Div 1 / Div 2 or ASME Sec.-III as and when specified. The welding and other fabrication requirements shall be as per PC-E-160.

16.23.11 Inspections and Testing

All fabricated EP's shall be inspected as per approved QA plan. The inspection shall cover visual examination, MPT, LPT, RT and UT such that these EP's are free from burrs, cracks, nicks and surface irregularities as per previous clauses of this specification. . The DP and Radiography examination and Air Hold Test shall be carried out as per specification No. PC-E-160.

16.23.12 Air hold test / Vacuum box test

All pipe and sleeve EPs of safety systems meant for sustaining pressure or otherwise specified shall be tested for leak tightness. The test pressure/holding time shall be as per the approved Drawings. Air pressure/vacuum shall be held minimum for 10 minutes to detect leakage and pin holes.

16.23.13 Rectification

Any rework / rectification on the EP's required due to improper placement after concreting shall be carried out by the Contractor to the satisfaction of Engineer without any extra cost. This shall also include any additional inspection requirements as decided by Engineer.

16.24 PAINTING

16.24.1 Contractor shall follow the best method of surface preparation and painting system. In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as instructed by Engineer. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system:

Manual or hand tool cleaning

Mechanical or power tool cleaning

Blast cleaning.

16.24.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a

clean and dry surface is obtained. The minimum acceptable standards in case of manual or hand tool cleaning shall be St2 or equivalent, in case of mechanical or power tool cleaning it shall be St3 or equivalent, in case of blast cleaning it shall be Sa 2 ½ or equivalent as per Swedish Standard SIS-055900 / ISO-8501-1.Where highly corrosive condition exists, then the blast cleaning shall be Sa3 as per Swedish Standard. Prior to surface preparation all other contaminants, oil, grease etc. Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%. Engineers reserve the right to instruct the type of surface preparation depending upon the condition of material.

16.24.3 Irrespective of the method of surface preparation, the first coat of primer must be applied on dry surface immediately and in any case within 4 hours of cleaning of surface. However at times of unfavorable weather conditions, Engineer shall have the liberty to control time period, at his sole discretion and /or to insist on recleaning, as may be required, before primer application is taken up. In general during unfavorable weather conditions, blasting and painting shall be avoided as far as possible.

16.24.4 Surfaces shall not be coated in rain, wind or in environment where injurious airborne elements exist, when the steel surface temperature is below 5^0C and the humidity is greater than 85%.

16.24.5 To the maximum extent each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spot or areas missed in the application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet & dry film thickness.

16.24.6 Paint manufacturer’s instructions shall be followed strictly at all times. Particular attention shall be paid to the following.

16.24.7 Instructions for storage to avoid exposure as well as extremes of temperature.

16.24.8 Surface preparation prior to painting, Mixing and thinning, Application of paints and the recommended limit on time intervals between coats.

16.24.9 Painting shall be carried out preferably by spraying. Brushes may be used sparingly at certain locations only and the brushes used for painting shall be of a style and quality that will enable proper application of paint. Type of brush shall be chosen according to its application and there shall be a minimum of brush marks left in the applied paint. Engineer reserves to instruct type of application of paint.

16.24.10 Joints to be site welded shall have no shop paint for at least 50 mm from the welding zone. Similarly steel surfaces shall not panted in areas where connection is by use of friction grip bolts. On completion of joint the surfaces shall receive the painting as specified.

16.24.11 Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from

the same manufacturer.

16.24.12 Contractor shall furnish all the characteristics of paint material along with the test certificates. All paint material shall be of first quality.

16.24.13 All Structural steel surfaces except EPs shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surface of the first coat during transport from shop to site and during erection shall be provided with a touch-up coat of the primer. The field primer shall be compatible with the shop primer.

16.24.14 The surface of steelwork to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter by grit blasting to white metal in accordance with IS 1477 –Parts I & II./ Swedish Standard SIS 05-5900. At places where grit blasting is not feasible, one coat of suitable approved anti-corrosive paint shall be applied.

16.24.15 The paint treatment specified shall be applied soon after completion of pre-cleaning or pre–treatment in order to prevent contamination of the surfaces in any way, either by brushing or by spraying on the thoroughly cleaned and dry surface as desired by the Engineer. Airless spraying shall be carried out unless specified otherwise by the Engineer.

Sl. No.	Structure	Surface preparation	Primer	Finish coat
1	All steel structure	Clean off dirt, rust, weld spatter & loose mill scale by shot blasting	1 coat of epoxy based approved zinc silicate primer to a film thickness of 75 microns	Hi-build Epoxy paint conforming to relevant specifications to a DFT of 200 microns

SS members shall be painted with the peel able paint, which shall be removed at the time of passivation.

16.24.16 Acceptance Criteria

a) All painted surfaces shall be uniform & pleasing appearance.
b) All epoxy and enamel painted surfaces wherever finish paint is specified shall be of uniform texture and high glossy finish.
c) All storms, splashes & spatters of paints shall be removed.
d) Surfaces shall meet the minimum specified DFT for their respective systems.

16.25 SPECIFICATION FOR FABRICATION OF STAINLESS STEEL EMBEDDED PARTS

16.25.1 SCOPE

This specification covers the requirements for the supply fabrication, inspection, testing and transportation of stainless steel embedded parts.

16.25.2 SPECIFICATION

Mechanical Engineering Drawing Standards - IS 696 (latest)
Assessment of surface roughness - IS: 3073 (latest)
Liquid penetrant inspection of metallic surfaces – ASME SEC V.
Ultrasonic Inspection of Metallic Surfaces – ASME sec V
ASME Boiler and Pressure Vessel Code Section IX Welding (Qualifications)

16.25.3 a) MATERIAL AND WORKMANSHIP

Materials which are not specifically covered & which are necessary for fulfillment of this specification shall be procure by the contractor. He shall be responsible for the correct procurement and performance of these materials, & shall replace at no extra cost to NPC any material failing to meet the requirements of the drawings & specifications.

b) WELDING ELECTRODES

Use of S.S. 308L or S.S.347 electrodes for welding SS 304L is recommended. Electrodes used on the work are to be approved by the Purchaser.

c) WORKMANSHIP

Workmanship shall be in accordance with high standards and adequate, to achieve accuracies and surface finish as shown on the approved drawings and this specification is to ensure satisfactory operation and service life of the liners.

16.25.4 WELDING

Weld shall be made by the weld procedure and welders qualified by tests in accordance with IS: 817 & 1181 and ASME Section IX as specified by the Purchaser. Welding procedure shall be prepared by the Contractor and submitted to the Purchaser for approval before the start of welding.

16.25.5 a) INSPECTION OF WELDS

All services and facilities related to testing and inspection to be provided by the Contractor. The inspection work shall be under the control of a competent Chief

Inspector whose primary responsibility is Inspection and reporting to Management. Inspection by NPC or their authorised representative shall not relieve the Contractor of any of the inspection duties called for herein.

All welds including fillet welds shall be subjected to Liquid Penetrant Test.

b) OTHER INSPECTION

The Contractor shall conduct 100% inspection & maintain record for all components and final grids system in accordance with the Approved drawings & Specification. This shall include inspection of the following:

Dimensional accuracy, surface finish, hardness, fit and alignment, workmanship, cleanliness and lubrication, completeness.

16.25.6 TRANSPORTATION

After completion of segmented fabricated line grid, it shall be thoroughly cleaned, protected from dirt, corrosion and damage and suitably braced and packed for transportation**.**

16.26 QUALITY SURVEILLANCE FOR STRUCTURAL STEEL & EPS

16.26.1 General

The Engineer shall subject all works and materials covered by this specification to inspection.

The Contractor shall provide free access in his shop during working hours for the inspection staff, designated by the Engineer, at all phases of the work and assist them where necessary in conducting the inspection. The Contractor shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and workmanship are in accordance with this specification, but it will be not relieve the Contractor of any of his responsibilities for the product. The inspector's inspection will include, but not be limited to, the following:

16.26.2 Material

The inspector will ascertain that only materials conforming to the requirements of this specification are used.

16.26.3 Dimension and Tolerances

The Engineer will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

16.26.4 Welding Procedure

The Engineer will witness the welding and testing of any procedure qualification tests that are required by this specification. The Engineer will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

16.26.5 Welding Equipment

The Engineer will check the welding equipment to be used for the work to ensure that it is in such condition as to enable qualified welders to follow the procedures.

16.26.6 Welder & Welding Operator Qualifications

The Engineer will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with ASME – Section IX.

When the quality of a welder or welding operators' work, appears to be below the requirements, the Engineer may require testing of his qualifications by necessary tests.

16.26.7 Welds

The Engineer will ascertain that the sizes, length and the location of all welds conform to the requirements of this specification and the approved fabrication drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

The Engineer will identify with a distinguishing mark of all parts of the joints that has been inspected and accepted.

The Contractor shall comply with all the demands of the Engineer to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgement of the Engineer, or its retention is not in accordance with the intent of the plans and specification, the Contractor shall remove and replace the damaged materials at his own cost.

17 FIRE PROOFING OF STRUCTURAL STEEL MEMBERS USING INTUMESCENT PAINTING

17.0 SCOPE

This specification covers the requirements in general that needs to be followed for thin Intumescent Coatings used as Passive Fire Protection measure on Steel Structures of defined fire ratings, wherever applicable. The specification in general covers the requirements for selection of coating, testing, application & quality control measures

which shall be followed to use the Thin Intumescent Coatings. Wherever Intumescent Paint is proposed to be used in radiation area, the adequacy of same shall be established prior to its use.

17.1 INTUMESCENT COATING SYSTEM

The system shall comprise the 3 layers i.e primer, basecoat and seal top or decorative coat. The Primer & Seal/Top coat shall be compatible with base coat. The product proposed for use shall be manufactured by a reputed & experienced company having In-house R&D & fire test facility, unless approved otherwise.

The Coating shall be certified from reputed agencies like UL (USA) & Warrington (UK) etc. The certifying agency shall be well recognized and acceptable to NPCIL.

Unless approved otherwise, the Primer, Intumescent base coat , seal coat or decorative top coat should be sourced from the same manufacturer, to assure their compatibility.

The coating system should be such, where recoating of the coating shall be feasible if required, with approved top / seal coat for asthetic reason. It shall also be feasible to repair the same as per approved procedure from Manufacturer in case of damage to Intumescent coating.

17.1.1 PRIMER

A protective coating, usually anti-corrosive, is applied to the substrate prior to application of the basecoat. It shall also provide adequate adhesion to base coat in case of fire.

For site applied Intumescent coatings, the primer is the only part of the total system that would normally be applied in shop and balance base coat & Seal Coats are applied a site.

17.1.1.1 PRIMER SELECTION

The choice and thickness of primer shall depend on

- the In-service environment, which affect the degree of anti-corrosive protection required.
- where the primer is to be applied, and subsequent Intumescent basecoat application requires a significant delay between steel preparation in shop and final erection and completion of coating at site, the primer needs to have suitable weathering properties and durability, it must be suitable for over-coating with the intumescent coating after the appropriate time interval, and it should be sufficiently tough to be transported with minimum mechanical damage. In such cases the primer may be applied in 2 stages, if recommended, by coating manufacturer.
- the primers having poor heat resistance, and likely to have a detrimental effect on the performance of the intumescent in a fire shall not be used.

- primers based on weaker solvents than the (solvent based) intumescent, may exhibit defects such as rivelling and/or wrinkling when over-coated, and therefore shall be avoided.
- the primer shall be compatible with base coat and generally manufactured by same manufacturer, In case primer from different producer, if used with prior approval, before application of the Intumescent basecoat, the confirmation from the Intumescent manufacturer shall be obtained in writing, such that the primer and Intumescent basecoat are compatible in both ambient and fire conditions. In such case the technical data sheet for the primer, the actual primer thickness and information regarding the length of time the primer has been applied should be shared with base coat material supplier, who should then be able either to give approval for use of the primer, or to provide alternative advice.

17.1.1.1.1 COMPATIBILITY OF INTUMESCENT COATINGS WITH ZINC RICH PRIMERS

Wherever Zinc rich primers, are used to avoid problems of inter-coat adhesion. It is essential that the zinc salts, if exist due to prolonged exposure prior to application of base coat, are completely removed by washing down with clean fresh water. Where full removal of zinc salts cannot be guaranteed, the option to remove the zinc coating and re-prime the steelwork shall be followed.

Formation of Zinc salts can be prevented by applying a tie-coat over the primer at the fabrication stage. The Intumescent coating can then be applied to the tie-coat.

The application of water based intumescent coatings(if approved to use) directly over zinc rich primers is not recommended.

In all cases, the intumescent coating manufacturer should be consulted to confirm the compatibility of the priming system with the intumescent system and, where applicable, the tie coat.

17.1.1.1.2 COMPATIBILITY OF INTUMESCENT COATINGS WITH EXISTING PAINT LAYERS

Steelwork requiring refurbishment will usually be treated with an existing coating system. The existing paint coatings are likely to be old and their adhesion to the substrate, or between layers of the system, may be poor.

In such cases earlier coating shall be completely removed and the application of a primer/primer system compatible with the new Intumescent system shall be applied. The old paint shall be preferably blast cleaned to Sa 2½ standard as defined in BS EN ISO 8501-1. The blasted surface provides a suitable base for the application of the new priming system.

In situations where site conditions may make abrasive blast cleaning impractical or unacceptable, the use of manual cleaning methods may be considered. Impact tools such as chipping hammers, needle guns are reasonably effective in removing old paint coatings . Power rotary wire brushes may also be used to remove the existing paint, where a compatible surface tolerant primer is used. When using power tools care should be taken to avoid polishing the surface, and to achieve an acceptable profile or anchor pattern.

The Intumescent system manufacturer should be consulted to provide advice about surface preparation standard, with appropriate supporting evidence.

Where a manufacturer wishes to demonstrate that compliance can be achieved by the application of an Intumescent system over existing painted surfaces of known generic type and thickness, fire test evidence should be available to provide a technical justification. Agreement should be reached with NPCIL about the applicability of the test data to the circumstances which prevail on the specific site.

17.1.2 BASE COAT

The base coat shall be Solvent based Intumescent Coating of approved Dry Film Thickness, unless approved otherwise.

The Intumescent coating (Base Coat) shall be fit for use for given "In service environment exposure condition". The coatings proposed to be used in exterior condition shall be specifically certified for its suitability for exterior use. Wherever, coatings of interior members needs to be left exposed, while erection for a reasonable period of time prior to completion of enclosure, the same shall be adequately protected with suitable seal coat to avoid any damage to base coat from moisture etc.

Wherever unusual conditions given below are likely to arise, the advice of the coating manufacturer about suitability of coating, should be sought:

- If environment change in the foreseeable future.
- If some form of local pollution present. For example, high levels of sulphur dioxide could produce acidic conditions and this in turn may influence the type of seal coat required.
- If conditions vary within the building. For example, roof spaces (of an air conditioned building) subjected to periodic condensation.
- If some elements of the construction particularly vulnerable to impact damage.
- If any unusual processes likely to cause localised special conditions, such as splashing, water pooling, localised high temperatures etc.

17.1.3 SEAL COAT OR TOP COAT

A Polyurethane coating of specified thickness shall be applied over the basecoat to prevent the basecoat from environmental degradation and abrasive damage as seal coat.

17.1.4 FIRE TESTING OF COATING

Fire protection systems for steel structures are tested for their ability to retard the rate at which the steelwork heats up in a fire.

If desired by NPCIL, the coating system (Inclusive of all 3 coats, as proposed to be used) shall be independently evaluated by performing the fire testing in independent approved laboratory, before acceptance of product. The number of test samples shall be decided based on variability of coating thickness proposed to be used in the project and with mutual consent of NPCIL & Contractor. Generally, for a given fire rating and coating thickness the member having highest Hp/ A (Heated Perimeter/ Cross-sectional Area) shall be most critical and selected for testing. The cost of testing upto 2 samples are deemed to be included in the coated rate . In case if it is decided to test more than 2 samples, the cost of such additional tests (Beyond 2 Samples) including materials & labour shall be reimbursable to the contractor on actual expenditure, If the product is successfully tested and qualified. However, in case of failure of coating on testing, the cost of testing shall be compulsorily borne by the contractor.

17.2 FIRE RATING

It is defined as the ability of an element of building construction/ component for structure to fulfill, for a stated period of time, the required stability, fire integrity and or thermal insulation and/ or other expected duty in a standard fire resistance test.
The fire resistance requirement for a building is defined in terms of the fire resistance period and stated in terms of minutes (15, 30, 45, 60, 75, 90 or 120 minutes) based on standard time temperature curve as per ISO 834 / IS 3809.
The fire rating of the members shall be derived, based on relevant codal provisions or from Fire Hazard Analysis. The fire rating for each member shall be as specified and approved by NPCIL.
Wherever specified, the ability of a component or material to achieve the required fire resistance period is demonstrated by subjecting it to a standard fire test as defined in BS 476-20 /21 or BS EN 1363-1 or ASTM E119 as approved from NPCIL.
In case of Intumescent Coating the adequacy of the system under test, shall be decided based on the fulfillment of requirement, that the substrate temperature does exceed the critical temperature when heated for rated duration as per standard time temperature curve given in IS 3809.

17.3 CRITICAL TEMPERATURE

Unless specified otherwise, the critical temperature for member with 4 side exposure & 3 side exposure shall be 550 deg C and 620 deg C respectively.

17.4 FILM THICKNESS OF INTUMESCENT SYSTEMS

Primer, Base Coat and seal coat / decorative top coat thicknesses shall be as specified and approved by NPCIL.

Unless specified otherwise, the thickness of primer & seal coat shall not vary with size of member, for a given fire rating. However, the thickness of base coat may vary as per its Section Factor, fire rating, critical temperature & exposure condition etc.

17.4.1 PRIMER FILM THICKNESS

The thickness of primer shall be as specified and approved by NPCIL. In no case, the primer thickness shall exceed the upper limit, if any, specified by the coating certifiying agency or by the coating manufacturer, above which the performance of the intumescent may be impaired in a fire situation.

Wherever, steelwork delivered to site is treated with a primer applied elsewhere in shop, the compatibility of the primer applied shall be ensured with Intumesecent coating by the coating manufacturer. The correct thickness of the primer applied in shop shall be properly documented and informed to Base coat applicator, to work out the thickness of base coat from combined thickness measured after application of base coat. In case, such records are not available, the site applicator must conduct a primer thickness survey prior to commencement of intumescent application to the satisfaction of NPCIL.

17.4.2 BASE COAT THICKNESS

Unless specified otherwise, the DFT of base coat shall be derived based on charts of proposed coating material, certified from the reputed agencies like UL (Under Writer Laboratories, USA) & Warrington, UK etc. The base coat thickness shall be derived based on critical temperature of the member, its desired fire rating, its section factor , no of sides exposed to fire etc. using above certified charts. The correct film thickness must be determined for each section, in order to produce a list of section sizes with their associated film thicknesses for the entire project.

The contractor shall prepare a painting schedule of primer, intumescent coating & seal coat thicknesses required to provide fire protection to each of the steel sections to achieve the specified fire resistance periods. This schedule shall be submitted to the NPCIL for review and approval, prior to commencing the works. The schedule must include, but not be limited to, the following.

(i) Fire resistance period(s) required.
(ii) Steelwork references as noted on general drawings.
(iii) Steelwork section sizes and section factors.
(iv) Details of any partial fire protection, if provided by concrete floor slabs etc.
(v) Name of intumescent product(s) specified / selected.
(vi) Method used to determine required coating thicknesses.

The average measured dry film thickness of any face of any member should not exceed the manufacturer's recommended maximum thickness for the particular member shape and orientation.

17.4.3 SEAL COAT FILM THICKNESS

The coat thickness shall be as specified and approved by NPCIL.

17.4.4 PAINT THICKNESS ON BOLT HEADS AND STEEL TO STEEL CONNECTIONS

Where structural steelwork is treated with intumescent in shop and erected in finished condition, special provision has to be made for the coating on site of bolt heads and other surfaces not previously fire protected. As per recommendations of BS 5950 Part 8, the protection coating thickness on bolt heads and connections should be the same as that on adjacent steel sections.

Where the coating operation is delayed for any reason or where the bolts/ connections are made of a special material proper cleaning prior to coating shall be carried out. In such case a special adhesion primer may be required before application of the intumescent in consultation with coating manufacturer and approval of NPCIL.

17.4.5 FILM THICKNESS DETERMINATION

The correct thickness of intumescent coating system applied on the members shall be confirmed before proceeding to application of the decorative topcoat, as any deficiency in intumescent thickness can be best corrected at this stage.

The average DFT of the primer coat shall be properly recorded and verified in the shop. If same is not available it shall be measured physically at site. prior to application of Base Coat. After application of the intumescent basecoat, the average primer thickness should be subtracted from measurements taken on the basecoat, to establish the true intumescent thickness.

The thickness of topcoat must be confirmed in the same way as for the intumescent basecoat above.

Where decorative appearance is important and requires additional coats of finish, or where additional topcoat thickness is required to protect from severe environmental conditions, the intumescent manufacturer should be consulted to confirm that the additional thickness will not inhibit the fire resistance of the system.

17.5 IN-SERVICE ENVIRONMENT

The nature of the environment to which the coatings will be exposed may affect their durability or their performance in a fire situation, and must therefore have a major influence on the properties required of them. Environment may have a significant

bearing not only on the choice of intumescent basecoat, but also on the type and thickness of anticorrosive primer and on the type and thickness of seal coat.
For steel protection generally, BS EN ISO12944-2:1998(7) defines a number of environments in terms of 'corrosivity', based on relative corrosion rates of carbon steel, as follows:
Category C1 Very low
Category C2 Low
Category C3 Medium
Category C4 High
Category C5-I Very high (Industrial)
Category C5-M Very high (Marine)

ISO 12944 relates these categories to the composition and thickness of different protective coating systems required to provide short, medium or long term protection against corrosion, but only categories C1 and C2 would be considered typical of most thin film applications.

Examples of typical environments for each category are given in Table 17.1 below.

For C1 environments (the most common for fire protection) corrosion protection may not be strictly necessary but for site-applied intumescent coatings an anticorrosive primer may still be specified to provide temporary protection .

For all other environment categories some degree of corrosion protection would normally be included, but the specifier must also consider the type and thickness of seal coat that may be necessary to prevent degradation of the intumescent by moisture from humid atmospheres, condensation etc.

TABLE 17.1: CLASSIFICATION OF ENVIRONMENT TYPES

Corrosivity Category	Corrosion/ Exposure Rating	Examples of typical environments in a temperate climate (information only)	
		Exterior	Interior
C1	Very low	N/A	Inside heated or air-conditioned buildings with clean atmospheres. Low relative humidity and no likelihood of damp or condensation e.g. offices, schools, shops, hotels.

C2	Low	Atmospheres with low level of pollution and fairly dry climate. Mostly rural areas. Intumescent use mainly in sheltered locations e.g. under canopies.	Occasional damp or wet conditions. Unheated buildings where water leakage or condensation may occur, e.g. unheated warehousing, sports halls, plant rooms etc and in roof voids.
C3	Medium	Urban and industrial atmospheres, moderate sulphur dioxide pollution. Coastal areas with low salinity. Examples would include exposed car parks.	Constant damp atmosphere, but may be warm and well ventilated. Production rooms with high humidity and some air pollution, e.g. food processing plants, kitchens, laundries, breweries, dairies.
C4	High	Industrial areas with high sulphur dioxide pollution and coastal areas with moderate salinity. Typical areas include tank farms, petrochemical installations etc or exposed exterior surfaces of any structure in a polluted environment.	Interior of chemical plants subject to continual injection of chemical vapours or steam in the atmosphere. Constant warm and high humidity conditions such as in swimming pools. Coastal ship and boat yards.
C5-I	Very high	Industrial areas with high humidity and aggressive atmosphere. Thin film intumescents should only be used with manufacturer advice.	N/A
C5-M	Very high	Coastal and offshore areas with high salinity. Thin film intumescents should only be used with manufacturer advice.	N/A

17.6 STORAGE

The storage of all material(s) should be strctly in accordance with the manufacturer's recommendations . As a general guide, the storage temperature for all material(s) will be within the range of 5 -30°C, and any water based materials in particular should always be protected from frost. Material containers should remain unopened until needed and should be used in date order (FIFO).

All materials delivered to site must be used within the manufacturer's stated shelf life, or otherwise be approved in writing by NPCIL, if declared suitable for use by the original manufacturer.

17.7 APPLICATION OF COATING SYSTEM

17.7.1 PREREQUISITES

Application must not proceed, if the prevailing environmental conditions are outside the limits set out in the manufacturer's technical data sheets.

As a general rule, environmental conditions – air and steel temperatures, humidity and dew point – should be determined before commencement of work in the morning, afternoon and evening (if appropriate), and at other times if conditions show a noticeable change (e.g. if it starts raining). All measurements should be logged and be available for inspection at all times.

Prior to site application, all surfaces to be coated should be in a clean, dry condition and any areas not requiring fire protection or which may be exposed to overspray should be appropriately protected by masking.

The applicator should ensure that all equipment required to carry out the surface preparation and application of all components of the intumescent coating system, according to technical specification, are available and in good working order.

The applicator must ensure that all relevant Health and Safety data sheets, application instructions and method statements are available and are fully understood.

Where required, mixing should be carried out in accordance with the manufacturers' instructions. Materials taken from store should attain the temperature recommended for use before being applied.

The scheduling of the works should be such that sufficient areas are made available, allowing free access for the applicator of the intumescent coating system to apply the material to the required specification.

All work should be scheduled to ensure that the conditions required by the manufacturer (temperatures and humidity, over-coating times etc) can be met.

It is particularly important that where application is to be carried out in a partially clad building (i.e. not theoretically open to the elements), the contractor ensures that the building is water-tight and that areas where coatings are to be applied are not directly exposed to external weather conditions at any time.

17.7.2 MONITORING OF ENVIRONMENT CONDITIONS

No application should take place on site when environmental conditions – air and steel temperatures, relative humidity, dew point – are outside the limits laid down by the coating supplier, to avoid any detrimental effects on both film formation and integrity of the coating (especially water based systems) as well as on long term performance.

Typically, steel temperatures should be more than 30 C above the dew point to ensure that no (visible or invisible) moisture or condensation is present on the surface during application.

The applicator's shall monitor these conditions in accordance with the specification, and to maintain auditable records to demonstrate compliance.

17.7.3 SURFACE PREPARATION

Steel surfaces should be prepared by removing scale and rust using abrasive shot blasting to a minimum standard of Sa2½ as defined in BS EN ISO 8501-1: 2001 "Preparation of steel substrates before application of paints and related products"

Prior to the commencement of blast cleaning all steel surfaces should be clean and dry. Oil and grease contaminants, if present, should be removed by the use of suitable emulsifying degreasers, suitable clean organic solvents or steam cleaning before the commencement of blasting.

A surface profile shall be within the range of 35 – 75 micron in general suiting to primer and as specified by the Coating Supplier and shall not exceed 100 microns.

All dust and spent abrasive must be removed from the prepared steelwork by blowing down with clean dry compressed air.

17.7.4 APPLICATION OF PRIMER

The primer of specified thickness should be applied before the blast cleaned surface deteriorates.

Where the steel sections are (more normally) blasted and primed in shop, the same surface preparation standards as above would be specified, but after transportation and site storage further measures need to be included to ensure cleanliness of the primer prior to over-coating with the Intumescent basecoat. In such case the primer may be applied in 2 stages, if recommended, by coating manufacturer. The first stage primer shall be applied in shop to protect the shot blasted surface till final painting, and second coat of primer shall be applied prior to application of Intumescent Coating in consultation with coating manufacturer. The necessary surface preparation at each stage shall be carried out in line with coating manufacturer recommendations. The next stage of coat shall be applied after minimum curing time of previous coat and shall also be completed before the end date if specified by the coating manufacture.

The coating manufacturer shall ensure and certify that the primer & process followed in such a way shall not adversely affect the performance of the coating.

The primer should be applied to the specified dry film thickness and the thickness measured in accordance with the approved procedure.

When thicknesses are found to be outside the specification, the advice of the designer and/or primer and intumescent coating manufacturer should be sought and remedial action carried out as necessary.

Because different structural steel sections may require different intumescent basecoat thicknesses, it is important to ensure that all sections are correctly marked or otherwise identified for application and record purposes. Marking is best carried out after completion of priming and should not interfere with the application or operation of the intumescent coating system.

Where unprotected elements meet fire protected elements in a structure, it is normally considered good practice to overlap the fire protection onto the adjoining 500mm of 'unprotected' structural steel to limit heat transfer into the protected substrate.

17.8 QUALIFICATION OF APPLICATOR

The fire performance of a product, component or structure is dependent on satisfactory site application and maintenance. Competence in application requires an understanding of the importance of such factors as surface preparation, data sheet limitations for conditions during applications, achievement of film thickness etc. Such competence is important for any coating operation, but for intumescent paints the potential consequences of coating failure make the standard and control of application quality even more critical. Therefore, these coating shall be applied by experienced persons who know and understand not only the practicalities of coating application, but also the importance of attention to detail in the installation process. The applicator shall be certified by the Intumescent Coating Manufacturer, which shall provide confidence in the appropriate standard of workmanship being provided.

17.9 APPLICATION METHODS

The application of all coatings should be carried out fully in accordance with manufacturers' technical data sheet requirements and the applicator's method statement approved by NPCIL. These in turn must reflect fire test and assessment conditions.
While airless spray is generally the preferred method of application for most coatings, the use of this method on site may be restricted, in such cases either provision to protect adjacent buildings and the surrounding environment from overspray shall be made, or brush/ roller application may be followed if permitted as per coating manufacturer recommendations.

Where spray is not possible, a larger number of coats by brush or roller may be required, and minimum and maximum over- coating times must be observed. In such case he recommended thicknesses provided on manufacturer's data sheets, along with the maximum achievable thickness per coat by the different methods may be used as basis of application.

17.10 THINNING AND EQUIPMENT CLEANING

Thinning of Intumescent product may be permissible to aid application characteristics with prior approval of NPCIL, particularly where ambient temperatures affect product

viscosity and make a good quality finish difficult to achieve. However, excessive thinning can create sagging, drying and film formation problems, particularly where high film thicknesses are involved, so all thinning is subject to approval by the manufacturer in writing. Only thinners approved by the manufacturer may be used, if approved.

Wherever, solvent is used for equipment cleaning, the same should be approved by the coating manufacturer as being compatible with the coating system, as incompatible gun-washes left in equipment overnight can give rise to film formation defects if mixed in with the coating.

It should be noted that thinning with solvent will invalidate the wet to dry ratio given on the product data sheet and may significantly affect the VOC (Volatile Organic Compound) content of the coating, and hence its use should be limited so that it does not adversely affect compliance with environmental legislation and does not causes any health hazard to the applicator and surroundings.

17.11 HANDLING, TRANSPORTATION AND STORAGE OF SHOP-PRIMED STEELWORK

The primers used for the shop priming of structural steelwork shall be fairly tough ,resilient, and shall be resistant to mechanical damage . Further, the contractor is required to implement protective measures and appropriate care during the transport, storage and erection of steel structures.

Coatings should be sufficiently dry before handling and members should be lifted at designated lifting points or by using lifting brackets where available. The use of lifting chains in contact with coated steel is preferred to strops/webbing slings as the former cause only minimal damage that is normally easy to rectify. Member shall be preferable lifted in single lift.

The loading of trailers should be carefully planned, with timber supports positioned, where possible, in uncoated contact areas (e.g. areas to receive bolted connections). Where contact of supports with coated areas is unavoidable, members should be supported on their toes to minimise the contact area. Where thin-film prefabrication primer only has been applied in shop, members which may fill with water should be prevented from doing so by the use of covers to avoid premature breakdown under immersion. Loads are best secured with the careful use of clean chains and it is advised that the loaders wear overshoes and where possible avoid walking on coated surfaces in order to minimise contamination.

Where site storage is unavoidable, similar care should be taken in the handling and support of the coated steel using the same lifting and support points as those used in transportation. Where possible members should not be stacked and water ponding should again be avoided using localised protection where necessary. The contractor should be made fully aware of the importance of good handling practice and storage areas should be roped off with signage clearly explaining the need to avoid contamination and mechanical damage to the coating finishes.

Similar care should be taken during the erection phase, with any lifting activities making use of strategically positioned holes, lifting lugs and brackets etc to minimise damage to the body of the paintwork.

17.12 TREATMENT OF SHOP-PRIMED STEELWORK AT SITE

17.12.1 REPAIR OF TRANSIT DAMAGE

Despite the contractor's efforts to be careful, some damage to the coating will inevitably occur during handling and transportation. Further damage may occur as a result of site modifications, welding etc prior to the application of the intumescent basecoat.

The nature and extent of primer repair required will vary, dependent on

- The scale of damage incurred.
- The degree of deterioration of the damaged surface.
- The type of exposure – i.e. the service environment and the importance of the primer in providing long-term anticorrosive protection.

Even where damage to the primer is extensive, provided that the exposed steel surface has not badly corroded it may be sufficient to re-prepare the surface to an acceptable standard prior to application of the intumescent basecoat overall i.e. without reinstating the primer. This might be acceptable, for example, where conditions during application are acceptable and subsequent exposure is to an environment of corrosivity category C1, provided the intumescent coating manufacturer agrees.

17.12.2 Repair of weld damage area

In cases where on-site welding, cutting or grinding has been necessary, all affected areas must be re- prepared to a standard agreed with the intumescent manufacturer, and cleaned down to remove any resultant contamination.

In general, site welding would be carried out prior to application of the intumescent basecoat, and the welds and heat-damaged areas then re-prepared by suitable mechanical means such as power discing and/or grinding prior to reinstatement of the primer. Where welding is carried out after application of the intumescent basecoat, any heat-damaged coating should be cut back to a sound coating (distance) prior to re-preparation and reinstatement of all coats in the area of repair.

Where subsequent service is to be in an environment subject to damp or wet conditions – e.g. humid buildings without air conditioning, swimming pools etc – the anticorrosive coating may be important to the long term performance of the system and a good standard of surface preparation and reinstatement of the full anticorrosive primer thickness may be necessary. In all cases, the advice of the intumescent manufacturer should be followed.

17.12.3 Contaminated and corroded primer

Where a thin coat of primer is specified to provide protection of the blast cleaned steel during the transport and erection stages only, any delays in the build programme may

result in some breakdown of the coating and consequent corrosion (rust rashing) of any exposed steelwork. In such cases if decided by the Engineer, re-preparation shall carried out by the contractor. Depending on the extent of corrosion and the nature of the intended service environment, the decision may range from no re-preparation to manual re-preparation of affected areas followed by immediate application of the intumescent basecoat overall, or manual preparation to BS EN ISO 8501-1 St3 standard, followed by re-application of primer prior to completion of intumescent coating. Wherever, the primer forms a functional part of the long term protective system and to be used under severe exposure environment re-preparation at site shall be required.

Where the primer is in good condition but in a contaminated state, it be cleaned using suitable methods such as washing using detergent and/or fresh water pressure washing and allowed to dry before application of the intumescent basecoat. The decision of NPCIL in this regard shall be final.

17.13 SEALING OF INACCESSIBLE AREAS

If some gaps are present in structures, where moisture ingress may occur and if not sealed may cause problems such as blistering or degradation of the intumescent coating after application. Such areas need to be sealed prior to application of the intumescent basecoat, with a moisture resistant intumescent mastic or equivalent, prior to the application of intumescent basecoat.

Areas like interface between the top flange and concrete decking, may allow moisture to penetrate and this will take a long time to dry out, even if environmental conditions are satisfactory for paint application.

17.14 REPAIR PROCEDURE

During the application process and after completion of the work, repairs may be necessary to ensure that the standard of fire protection, surface integrity and finish is in accordance with the original specification. The cause of the damage or degradation should be addressed prior to carrying out the repairs, to avoid any repetition.

Before carrying out on-site remedial works, a written Method Statement for repair procedures shall be prepared by the contractor and submitted to the NPCIL for review and approval.

The contractor shall be responsible for identifying all areas requiring remedial works and for rectification in accordance with the coating manufacturer’s recommendations. Issues such as compatibility, effectiveness and adhesion of combined thicknesses etc shall be considered while taking the decision.

In case, where the intumescent coating has detached due to mechanical damage, or suffered localised degradation due to water ingress, the normal repair procedure of mechanical removal of the damaged or denatured coating to a firm (unaffected) edge, followed by reinstatement of the system to the original, specified thickness shall be followed.

17.14.1 Repair of film thickness deficiencies

If the dry film thickness of the intumescent basecoat or topcoat, does not comply with the nominal dry film thickness stated in the schedule of thickness, work shall be undertaken to bring the affected area up to the required thickness.

Where a decorative finish has been specified, the contractor shall make provision for the removal of all visible dirt from the surface of the coating, following erection of the steelwork.

17.14.2 Repair of damage to completed Intumescent coating systems

Remedial work on complete fire protection systems will depend on both the extent of the damage and whether or not a seal coat was applied to the original coating.
Minor damage, such as chips and scrapes, will not normally affect the performance of the material unless the service environment is wet or exposed, in such case damage may allow moisture ingress and lead to degradation of the intumescent. It is therefore recommended that minor damage should be repaired with the approval of NPCIL at the earliest opportunity, following the procedure given below:

a) In cases of damage to the basecoat, the damaged area should be cut back to a firm edge. If the primer coat is damaged, any corrosion products which may have formed should be removed and the steelwork "patch primed" using a suitable compatible primer.

b) If only the basecoat is damaged, fresh basecoat or approved repair material should be applied to match the existing thickness, taking care not to excessively overlap onto the surrounding intact seal. When the dried intumescent material matches the surrounding thickness, the recommended seal coat (if any) should be applied either to the patch repair or overall.

c) If only the seal coat is damaged, fresh seal coat should be applied, either to the localised area, or over the whole section.

In the unlikely event that major repairs are required (i.e. due to water or chemical attack), the intumescent coating manufacturer should be consulted for expert advice and repair shall be carried out as per approval of NPCIL.

17.15 HEALTH AND SAFETY PROVISIONS

Products used on site shall comply with the recommendations of manufacturers' health and safety data sheets, and that the safety of all personnel in the vicinity of the application is protected. During and throughout the application process, full compliance with all relevant Health and Safety and Environmental legislation must be demonstrated. As a minimum this includes

- Observance of all precautions and conditions for use of the coating system, as defined in the manufacturer's Product Safety Data Sheets.
- Compliance with relevant Site Storage Regulations.
- Compliance with all applicable relevant Waste Disposal Regulations, in particular for the Hazardous Waste.

17.16 DESIGN LIFE AND LIFE TO FIRST MAINTENANCE

In general the intumescent systems along with seal coat should not require maintenance before 15 years, other than for decorative purposes or where mechanical damage has occurred and shall be guaranteed for same. The thickness of the seal coat shall be decided according to above requirements.

The Coating shall be regularly and frequently inspected of the condition of the fire protection. A schedule of regular maintenance shall be prepared in service. Wherever, there is any doubt about the capability of a thin film intumescent system to provide the required long term durability, a thick film system may be advised.

17.17 QUALITY PLAN, INSPECTION CRITERIA AND METHODOLOGY

17.17.1 QUALITY PLAN

Competent contractors and applicators shall have in-house systems in place to control site work and to demonstrate compliance with specification requirements. The quality plan shall cover the sequence of activities required to deliver the specified quality of finish. This plan shall also identify the inspection stages and hold point in the process, and shall be submitted to NPCIL for approval prior to commencement of the work.

17.17.2 Measuring Equipment

The following fully calibrated and certificated measurement equipment to be available on site

- Where steel surface preparation is to be carried out at site, pictorial standards for blast cleaning and for manual / mechanical surface preparation as supplied with EN ISO 8501-1:1988 should be available to ensure the correct standard is being achieved.
- Comparator plates or Testex tape and micrometer are required to determine the blast profile, where relevant. EN ISO 8503-1:1988 and EN ISO 8503-5:2004 apply.
- Ambient temperature thermometer.
- Minimum – maximum thermometer.
- Steel temperature gauge, preferably electronic.
- Whirling hygrometer, together with a relative humidity and dew point calculator as included in EN ISO 8502-4:1999, or electronic equivalent.
- Instruments which provide ambient and substrate temperatures, relative humidity and dew point calculations automatically.
- Tape measure to check steel section sizes, if necessary.
- Wet film thickness gauges.
- Dry film thickness gauges having a measurement range appropriate to the specified dry film thickness. Ideally the instruments used should have the capability to record

thickness readings in batches, and it would aid the completeness of records if the readings were also downloadable to computer.

17.17.3 Site inspection criteria

Typically, the inspection criteria shall include the following

1. Surface preparation

- Surface preparation standard – as specified, usually against EN ISO 8501-1 or equivalent
- Surface profile minimum and maximum – as specified (EN ISO 8503-2) or equivalent
- Dust or other contamination – visual or EN ISO 8502-3

2. Application

- Air temperature, substrate temperature, relative humidity and dew point (throughout the application process) – as specified or as manufacturer's data sheet.
- Batch numbers of all products used
- Dates and times of application and compliance with recommended over-coating times from manufacturer's data sheets
- Wet film thickness checks

3. Dry film checks

- Dry film thickness survey and records
  (i) at primer stage
  (ii) after application of intumescent basecoat and
  (iii) on completion of coating

  Thicknesses at each stage should be in accordance with the specification.
- Visual appearance – as specified or in accordance with agreed standard.

NB: Dry film thicknesses should always be checked against the approved film thickness schedule, which defines the required thickness for each individual steel member. Drawings or tables showing the correct thickness for each member must therefore be available to the inspector (contractor's QA representative or NPCIL representatives) prior to a dry film thickness survey.

17.18 INSPECTION METHODOLOGY

17.18.1 WET FILM THICKNESS

Wet film thickness measurements should be taken during application using a wet film gauge. These readings will provide a guide for the applicator to ensure that the required dry film thickness of the primer/basecoat/seal coat will be achieved. Wet film thickness measurements indicate the thickness of an individual coat. Care should be taken when applying subsequent coats, as readings may be misleading due to the gauge sinking into a softened previous coat.

Information on the wet film thickness necessary to give a specified dry film thickness should be obtained from the relevant intumescent manufacturers' technical data sheet(s).

17.18.2 Dry Film Thickness (DFT)

17.18.2.1 MEASURING GAUGES

The method of Dry Film thickness determination shall use a gauge employing the electro-magnetic induction principle. Such instruments shall have a range appropriate to the specified dry film thickness and shall be calibrated on a smooth plate prior to use. Calibration should use shims appropriate to the specified film thickness.

If feasible, the instruments should be capable of storing data. Ability to print and/or download to computer.

17.18.2.2 Thickness measurement

Primer thickness may be determined either after application in shop, or on site prior to commencement of application of the intumescent basecoat.

Allowing for the thickness of primer applied, the total dry film coating thickness of the intumescent basecoat should be determined prior to the application of any specified protective/decorative topcoat(s). Measurement at this stage will more easily facilitate any subsequent corrections which may prove necessary.

If the total intumescent dry film coating thickness, allowing for the underlying primer, is found to be within specified tolerances, application of the next coat (usually a decorative and/or protective coat) can proceed.

If the total intumescent dry film coating thickness is found to be outside the specified tolerances, the procedure outlined in section 19.4 should be followed.

Indentation of the coating by the measuring instrument probe indicates insufficient hardness of the coating and measurements should be deferred. However, if programming requires coating to precede urgently, with prior approval of NPCIL, a shim of known thickness can be used to spread the load of the probe tip on the coated surface, allowing measurement to proceed before the coating has fully hardened. The dry film thickness of coating and shim together can then be measured and the shim value deducted to give the coating thickness.

Application within the specified tolerances shall also be ensured by careful monitoring of material usage and the elimination of surface defect prior to application.

When taking dry film thickness readings, it is recommended that no readings are taken within 25mm of the edge of an I section or within 25mm of the join of flange to web of an I section.

Taking the above into account, readings should be taken randomly over the remaining areas of the section with a frequency as described in clause 19.3 below.

17.18.3 Frequency of measurement

Sections should be measured in accordance with the following guidelines

A) For first 10% members or till consistent performance to the satisfaction of NPCIL is achieved, whichever is later, the thickness measurement shall done as per following frequency.

(i) I Sections, Tee Sections and Channels
Webs: Two readings per metre length on each face of web
Flanges: Two readings per metre length on the outer face of each flange
One reading per metre length on the inner face of each flange.

(ii) Square and Rectangular Hollow Sections and
Angles: Two readings per metre length on each face.

(iii) Circular Hollow Sections
Eight readings per metre length evenly spread around the section

Where members are less than 2m in length, three sets of readings shall be taken, one at each end and at the centre of the member. Each set shall comprise the number of readings on each face given by (i), (ii) or (iii) above, as appropriate.

Following guidelines for setting out a film thickness survey shall be followed.

- The contractor must provide suitable and adequate means of access, including to difficult and / or partially inaccessible areas. It is therefore important that surveys are scheduled when the fullest possible access is still available on site.
- All equipment used must be correctly calibrated, and if more than one party is carrying out thickness checks, agreement regarding calibration of all instruments must be reached before commencing.
- At least 10% of steel sections should be measured in accordance with the frequency set out in 19.3 A) above. These should include a representative mix of section sizes, and difficult access sections as well as those that are easiest to access.
- All other sections should be measured with reduced frequency with prior approval of NPCIL, unless the detailed survey (of 10% of sections) identifies a recurrent problem of thickness.
- If the detailed survey reveals a trend of unacceptable thickness, this should be taken into account when planning the remainder of the survey.
- In the worst case scenario, a full and detailed survey according to 18.3 A) above may be adopted.
- If certain faces of the sections are repeatedly found to be unacceptable (e.g. top flange or one face known to be difficult to access), the remainder of the survey should include detailed measurements of that face as well as random measurements of other faces.

- Where no unacceptable trends are identified, the remainder of the survey should consist of random readings taken at a frequency of 4-5 readings per metre length.
- Unacceptable low areas should be marked up for remedial coating by the inspector.

17.18.4 Acceptance criteria

The coating thickness acceptance criteria shall be as follows, assuming that the specified thickness is a nominal value:

(i) The average dry film thickness applied to each element shall be greater than or equal to the specified nominal value.

(ii) The average measured dry film thickness on any face of any member shall not be less than 100% of the specified nominal value.

(iii) Dry film thickness values less than 80% of the specified nominal value are acceptable, provided that such values are isolated and that no more than 10% of the readings on a member are less than 80% of the specified nominal value.

Where any single thickness reading is found to be less than 80% of the specified nominal value, a further two, or where possible three, readings shall be taken within 150 to 300 mm of the low reading. The initial reading may be considered isolated if all the additional readings are at least 80% of the specified nominal value. If one or more of the additional readings are less than 80% of the specified nominal value, further readings shall be made to determine the extent of the area of under thickness. In such cases, low thickness areas identified should be brought up to the required thickness before proceeding to the next application stage.

(iv) The average measured dry film thickness of any face of any member should not exceed the manufacturer's recommended maximum thickness for the particular member shape and orientation.

17.19 CORRECTION OF DEFECTIVE OR INADEQUATE COATINGS

17.19.1 THICKNESS CORRECTION

Wherever inadequate thickness is identified, the deficient area shall be identified and further coat(s) of intumescent product to bring the overall thickness up to acceptable standards shall be applied, prior to application of the final seal coat / decorative top coat.

However, if low thickness is not detected until after the seal coat / decorative top coat has been applied, detailed guidance must be sought from the intumescent coating manufacturer. In some circumstances – and with supporting test evidence – it may be possible to remedy the situation by the application of further coats of intumescent paint, but in the other extreme it may be necessary to remove previous coatings in order to build up the necessary fire protection from scratch.

Wherever the intumescent coating thickness exceeds the limits stated in the manufacturer's recommendations, guidance should be obtained from the manufacturer.

17.20 RECORDS AND REPORTS

Where appropriate, site records should contain the following information

17.20.1 VERIFICATION OF PRODUCT AND SPECIFICATION

Confirmation of product testing and certification, preferably in accordance with a third party certification scheme.
In addition, any contract specific requirements regarding product or specification should form part of the site records. For example, where appearance of the finish is important, and where sample paints or panels have been approved by the NPCIL, these should form part of the product dossier.

17.20.2 Contract documentation covering the fire protection product and its installation

- Substrate type (i.e. section sizes and shape, orientation, Hp/A value, etc.)
- Substrate location
- Surface preparation (i.e. degreasing, blast cleaning, etc. and standard)
- Identification of any primer and information concerning compatibility with intumescent coating.
- Evidence of third party product certification, including proof of specific testing for cellular beams and fire-engineered situations, giving relevant report reference etc.
- Declarations of Supply covering the fire protection products used.
- Batch numbers of products supplied.
- Thickness of intumescent coating required for the specified fire resistance period.
- Any variations or concessions agreed during the course of the contract.
- Design review to confirm any design changes and their effect on the specification, prior to commencement of application.

17.20.3 Quality Control Records

- All records should identify the areas inspected with reference to the relevant drawings, and should include
- Environmental conditions – air and substrate temperature, relative humidity and dew point.
- Dry film thicknesses per coat and for the full fire protection system, for each element of the structure. Measurements should include

- the member identification mark

- the number of readings taken
- maximum coating thickness recorded
- minimum coating thickness recorded
- average coating thickness
- any supplementary readings taken to establish if low readings (below 80% of specification) are limited and isolated areas.

• Variations, corrective actions or concessions carried out in relation to environmental conditions or dry film thicknesses.

17.20.4 Site Remedial Work

Where dry film thicknesses are checked after application of each coat, it is a fairly simple procedure to correct low thickness as this can be achieved by simply applying an additional coat (or part coat) before proceeding to the next stage of the specification.

If film thicknesses are not carried out with the required regularity, or if low thicknesses are not detected until the application process has been completed, it will be necessary to seek the manufacturer's advice regarding the best method of bringing the coating up to the required level of protection.

Advice may vary from complete removal of applied coatings, to selective removal of seal coat or, if supporting test evidence is available, to building up the thickness of the intumescent base coat (on top of the seal coat) followed by re-application of further seal coat.

In all cases, records must show the nature of defect, source of remedial advice and the full extent of remedial work carried out at site.

18 PRECAST CONCRETE

18.0 GENERAL

All concrete for precast concrete work shall comply with specifications for general concrete work and with the following additional requirements.

18.1 TOLERANCES

All units shall be cast as per detailed drawings furnished by the Engineer and to the tolerances indicated thereon. In the absence of any such indication, the dimensions shall not vary by more than ± 3 mm.

18.2 PLATFORM

All precast units shall be cast on a suitable yard, bed or platform with firm foundation and free from wind. The platform shall be fenced and shall have a curing tank of adequate size. The Contractor shall be responsible for the accuracy of the level or shape

of the bed or platform. A suitable serial number and the date of casting shall be impressed or printed on each unit. Each unit shall be concreted in one operation.

18.3 FORMS

The forms shall be steel forms with rigid steel frames or plywood forms if specifically approved by the Engineer. All component parts of formwork shall be so held that during concreting, there is no deformation of the form resulting in the concrete units not conforming to dimensions indicated on the drawings.

18.4 STRIKING FORMS

Side shutters shall not be struck in less than 24 hours for ordinary Portland cement after depositing concrete or as specified by the Engineer.

18.5 IDENTIFICATION MARKS

The surface of the underside or upper side, which is reinforced, shall be distinctly marked.

18.6 CURING

The blocks shall be kept at not less than 90% humidity immediately after manufacture for 24 hours and thereafter wet cured for a period of 10 days at a temperature of not less than 16°C. Rapid drying at the end of curing period shall not be permitted. Therefore they shall be stored under a safe and shaded enclosure/area. During this period, the blocks shall be handled carefully without causing any damage to corners, edges, surfaces etc.

18.7 HOISTING

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, the Contractor shall satisfy the Engineer or his representative that the methods he proposes to adopt for these operations will not overstress or otherwise affect seriously the strength of the precast units. Lifting hooks shall be embedded in correct position of the unit as shown in the drawings to facilitate erection. These shall be burnt off and finished after erection if directed so, by the Engineer. The units shall be incorporated in the work in accordance with details shown on drawings or as directed by the Engineer. Cracked or damaged precast pieces during, before or after erection shall be removed and replaced with good ones at the Contractor’s expense.

18.8 JOINTING

The joints shall be filled in with cement mortar 1:3 unless otherwise specified on the drawings. After jointing, the joint shall be cured for a minimum period of 10 days. All

sharp and abrupt ridges and marked depressions shall be removed by grinding or filling with cement mortar properly bonded to the concrete.

18.9 PRECAST CONCRETE HATCH COVERS

All concrete for hatch covers shall comply with specifications for general concrete work and with following additional requirements.

18.9.1 All Hatch covers shall be cast as per detailed drawings furnished by the Engineer and to suit the openings as built. The tolerances in dimensions shall be + 0 or – 3 mm unless otherwise noted on drawings. No two adjacent hatch covers shall differ by 2 mm in elevation. However, before concreting hatch covers, site measurements of actual openings at the final location of hatches shall be taken. Clearance around hatch covers shall be maintained, if required, by adjusting their overall dimensions to suit actual size of opening.

18.9.2 As far as possible these hatch covers shall be cast very near to their final locations to minimize handling of these hatch covers.

18.9.3 Each Hatch cover cast for a particular location/opening shall be properly identified by use of metal plates as indicated in drawings.

18.9.4 Each Hatch cover shall have MS edge protection angle frame along its perimeter, and vertical connecting angles, as given in detailed drawings. The frame shall be fabricated taking into consideration, the actual size of opening at its final location.

18.9.5 Care shall be taken while concreting to ensure that this framework does not get distorted during/after concreting.

18.9.6 All Formed surfaces of the hatch cover shall have F3 finish and unformed surfaces shall have U3 finish.

18.9.7 The Hatch covers/blocks will have to be transported and placed in final location by the Contractor. Rectification of hatch covers or blocks will have to be carried out by the Contractor if tolerances as specified are not achieved. The unit rate for this item shall include casting, curing, transporting to final location, erection, rectification and re-erection after painting at final location. Hoisting shall be done as per relevant clause for precast concrete given above.

18.10 SAMPLING, TESTING AND STRENGTH

Prior to manufacture trial mixes shall be prepared. When suitable mixes have been established, a sufficient number of blocks shall be cast to permit the Engineer to check the density and surface finish. If accepted these shall be standardized for all blocks to be manufactured. Provisions of IS: 1199 (Method of sampling and analysis of concrete) shall apply in addition to the requirement of this specification. The compressive cube strength of cured concrete blocks shall not be less than the specified strength at 28 days after casting.

19 MASONRY AND ALLIED WORKS

19.0 SCOPE

This chapter includes concrete block masonry, brick masonry, stone masonry, plastering, rubble soling for floors on grade, expansion and separation joints, sealing of joints, PVC/ GI water stops, flooring, skirting and dado, general area painting, steel doors, fire doors, sewer and plant drains, sanitary and plumbing items and other finishing works of the main plant structures.

19.1 APPLICABLE CODES

19.1.1 INDIAN STANDARD CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

IS: 277 Galvanized steel sheets (plain and corrugated)-specification

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete

IS: 513 Cold reduced low carbon steel sheet & strip

IS: 702 Specification for Industrial bitumen

IS: 712 Specification for Building Limes

IS: 777 Glazed earthenware wall tiles

IS: 782 Specification for Caulking Lead

I.S: 1038 Specifications for Steel Doors, Windows and Ventilators

I.S: 1200 Methods of measurement of building and civil engineering works

IS: 1081 Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators

IS: 1443 Code of practice for laying and finishing of cement concrete flooring tiles

IS: 1834 Specification for hot applied sealing compounds for joints in concrete

IS: 1838 Specifications for Preformed Fillers for Expansion Joint in Concrete Pavement and Structures(Non-Extruding and Resilient Type)

Part I Bitumen Impregnated Fiber

IS: 2116 Specifications for Sand for Masonry Mortars

IS: 2185 (part-1) Concrete masonry units — specification; part 1 hollow and solid concrete block

IS: 2212 Brick Works - Code of Practice.

IS: 2508 Specification for low-density polyethylene films

IS: 2645 Integral waterproofing compounds forcement mortar and concrete— specification

IS: 2932 Enamel, synthetic, exterior a) Undercoating b) Finishing - Specification

IS: 2933 Specification for Enamel exterior a) Undercoating b) Finishing

IS: 3462 Specification for Unbacked flexible PVC flooring

IS 3495 Methods of tests of burnt clay building bricks

IS: 3614 (Part-1)Fire-check Doors, Part I: Plate, Metal Covered and Rolling type

IS: 4351 Steel door frames - Specification

IS: 4671 Specification for expanded polystyrene for thermal insulation purposes

IS: 6248 Specification for Metal rolling shutters and rolling grills.

IS: 9862 Specification for ready mixed paint, brushing, bituminous black, lead-free, acid alkali, water and chlorine resisting.

IS: 12894 Pulverized Fuel Ash-Lime Bricks - specifications

IS: 14811Rolled copper plate, sheet, strip and foils for general engineering purposes - specification

19.2 CONCRETE BLOCK MASONRY

In general, concrete block masonry shall be used in the work. Concrete block masonry shall be of solid concrete blocks having minimum average compressive strength of 5 $N/MM^2$and density shall not be less than 1800 kg/m^3.Precast concrete block masonry shall be constructed in various sizes in cement mortar 1:4 by volume with blocks manufactured as per IS: 2185 (part-1) and as per drawings and direction of engineer using standard equipment.

If Contractor proposes to cast concrete blocks at plant site, they shall submit a detailed procedure for casting of concrete blocks and submit it for the approval of the Engineer. Work shall start only after approval of the procedure. Concrete blocks shall be tested in accordance with the provisions given in IS: 2185. Contractor shall submit inspection and test plan for approval of the Engineer. Contractor shall develop proper casting yard with curing facilities for casting concrete blocks as per direction of the Engineer.

For construction of concrete block masonry, code of practice for brick works i.e. IS 2212 shall apply.

19.2.1 MATERIAL

The following are the materials to be used in the concrete block masonry work.

19.2.1.1 CEMENT

Cement shall be as covered in per specification titled ‘Plain and Reinforced Concrete’.

19.2.1.2 SAND

The sand shall consist of natural sand from an approved source. The sand shall be hard, durable, clean and free from adherent coatings, mica, shale organic matter and appreciable amount of clay. The sand shall not have deleterious impurities such as iron pyrites, alkalis, salts, coal, mica, shell etc. Sand for masonry mortars shall have particle size grading conforming to IS: 2116 – latest edition. The grading of sand for use in mortar for unreinforced and reinforced brickwork shall be within the specified limits for respective works. The fineness modulus of sand for mortar used in brickwork shall be between 2.9 and 2.1. Where grading of the sand falls outside the specified limits due to excess or deficiency of coarse or fine particles may be processed to comply with the standard by screening and or blending.

19.2.1.3 WATER

Requirement of water shall be as covered in the specification for ‘Plain and Reinforced Concrete’.

19.2.2 STORAGE, HANDLING OF MATERIALS, CONCRETE BLOCKS, CEMENT, SAND, ETC.

Concrete blocks shall not be dumped at site & they shall be stacked in regularities, even as they are unloaded to minimise breakages and defacement of blocks. The supply/ manufacture of blocks shall be so arranged that at least fifteen days requirements of blocks are available at site at any time. Blocks selected for different situation of use in the work shall be stocked separately.

Cement, sand etc. shall be stored as stated in specification for 'Plain and Reinforced Concrete'.

Concrete shall be as per the specification for 'Plain and Reinforced Concrete'.

19.2.3 MORTAR

Mix for mortar shall be as specified in Schedule of Quantities. The cement and sand shall be mixed dry in specified proportion and then thoroughly mixed to proper consistency. No mortar that has stood for more than half an hour shall be used.

19.2.4 LAYING AND WORKMANSHIP

a) Blocks of same dimensions will be used on the same work except otherwise specially permitted by the Engineer. All blocks shall be sufficiently soaked but not excessively wet before laying. All blocks shall be soaked in water for a period of two hours before use and no blocks shall be used until there is complete cessation of bubbles when immersed in water. Concrete surfaces in contact with block masonry shall be hacked to remove the laitance and the surface roughened to the satisfaction of the Engineer for proper bonding.

b) All dirt and dust shall be removed from the block and the surfaces shall be moist at the time of laying.

c) No bats or cut blocks shall be used in the work unless absolutely necessary around irregular openings for adjusting the dimensions of different courses and for closers, in which case full block shall be laid at corners, the bats being placed in the middle of the courses.

d) The blocks shall be laid on a full bed of mortar and to line, level and shapes shown on the drawings. When laying, the blocks shall be slightly pressed so that mortar can get into all the pores of the brick surface to ensure proper adhesion. Cross-joints and wall joints shall be properly flushed in packed with mortar so that no hollow spaces are left. Blocks shall be handled carefully so as not to damage their edges. They should also not be thrown from any height to the ground but should be put down gently.

e) All courses shall be laid truly horizontal and all vertical joints made truly vertical. Vertical joints in one course and the next below shall not come over another and shall not normally be nearer than 1/4 of block length. Fixture, plugs, frames etc. if any, shall be built in at places shown in the drawing while laying courses only and not later by removal of the blocks already laid.

f) Care shall be taken during construction to see that edges of blocks at quoins, sills, heads etc. are not damaged. All block work shall be tightly built against columns, floor slabs, or other structural members around door and window frames with proper distance to permit caulked joints. In case of very dry weather, the surface of the block shall be kept wet to prevent drying of mortar. At the end of days work, provision shall be made to keep the surface of block work wet with water. Block work shall be added uniformly

throughout so that no portion of the work shall be left more than 900 mm lower than other. Verticality of walls and horizontality of the courses shall be checked very often with plumb bob and spirit level respectively.

g) Block work shall be laid out and arranged such that a minimum of cutting and shaping is required. Where necessary to trim block work units, they shall be cut, trimmed or broken at kerbs, or where required to a neat true line without chips on exposed faces.

h) Block work one and half blocks thick or more shall have both faces in true plane. Block work of lesser thickness shall have one selected face, in true plane.

i) Bond used shall be English bond and shall be carried throughout the work. At all corners alternate courses of brickwork shall be laid header and stretcher-wise as seen in the face so as to secure good bonds. The arrangement of bonds at quoins shall be symmetrical.

j) Blocks shall be laid in joints not exceeding 10 mm in thickness and this thickness shall be uniform throughout. Joints shall be struck flush with the face at the time of laying.

k) All joints on face shall be raked to minimum 10 mm depth while the mortar is still green to provide bond for plaster or pointing.

l) The rate of laying masonry may be up to a height of 1000 mm per day or as approved by the Engineer.

19.2.5 ENCASING OF STRUCTURAL MEMBERS

Where drawings show that structural steel columns and spandrel beams are to be partly or wholly covered with block work, the blocks shall be built tightly against all flanges and webs with all spaces between the steel and the block work filled solid with setting mortar and this mortar shall not be less than 12 mm thick.

19.2.6 REINFORCEMENT AND ANCHORAGE

a) For the walls, anchors in the form of M.S. flats or rods from columns and/or beams and embedment and any other anchoring and reinforcements, shown on drawings, shall be adequately embedded in the block work.

b) For reinforced blockwork, the reinforcements shall be as specified in the schedule of quantities. All reinforcements shall be thoroughly cleaned and fully embedded in the mortar. The thickness of the joints in blockwork containing steel bars shall be increased so as to have a minimum mortar cover of 6 mm around the bar interposed between the block and the reinforcement. Overlap in the reinforcement, if any, shall not be less than 50 times the diameter of the bar. The reinforcements shall be lapped with dowels left in R.C. columns or welded to steel stanchions. Where reinforced concrete bands are provided in the block walls, such bands shall be to the full width of the wall and the concrete of grade not lesser than M-25 shall be used. Such band will be measured separately under respective items of concrete in the Schedule of Quantities.

c) All half-block partition walls shall have M.S. reinforcing bars at every fourth course of the block work and they shall be securely anchored at their ends where the partitions bond.

d) All sash and door frames, louvers and other connections requiring weather proofing, shall be built in and the outside frames shall be cleaned out to uniform 20 mm depth and filled solidly with an approved elastic caulking compound applied with a caulking gun.

e) Scaffolding will generally be double but may be single if warranted for the particular work as approved by the Engineer. Scaffolding shall generally be erected with steel pipes. The Contractor shall take all measures to ensure safety of work and the working people.

f) Contractor shall be entirely responsible for any damage to property or injury to persons resulting from defective scaffolding, ladders and materials or otherwise arising out of default in this respect. Proper scaffolding shall be provided to allow, easy approach to every part of the work. Overhead work shall not be allowed.

19.2.7 CURING

All block work shall be kept constantly wet for at least 7 days from the date of laying of block work.

19.2.8 CLEANING

Upon completion of the masonry installation, all exposed block shall be cleaned of all mortar and cement grout incrustations and concrete stains. Protruding mortar joints shall be chipped off. As the cleaning progresses, all masonry work shall be examined and all imperfect jointing, nail holes, cracks, etc. shall be carefully pointed up and filled with mortar where required and the horizontal rakings left tooled and clean.

19.3 PLASTERING

19.3.1 WATER AND CEMENT

Water and Portland cement shall be as specified for masonry work.

19.3.2 SAND

Sand shall consist of natural sand, crushed stone sand or crushed gravel sand, from an approved source. The sand shall be hard, durable, clean and free from adherent coatings and organic matter, and shall not contain any appreciable amount of clay balls or pellets. The sand shall not contain any harmful impurities such as iron pyrites, alkalies, salts, coal, mica, shale or similar laminated or other in such form or in such quantities as to affect adversely the hardening, the strength, the durability, or the appearance of

the plaster or applied decoration, or to cause corrosion of any metal in contact with the plaster. Total of all deleterious substances shall not exceed 5% by weight. The sand shall be properly graded and of medium size with a fineness modulus of 2.0 to 2.2.

19.3.3 STORAGE OF MATERIALS

Cement and sand shall be stored as specified in specification for 'Plain and Reinforced Concrete'

19.3.4 MIX

The Mortar for plastering shall be mixed in suitable mechanical mixer in the proportion as indicated in the schedule of quantities. Water proofing compound conforming to IS: 2645 of approved manufacturer shall be added to the mortar mix for external plastering and finishes in the proportion as specified in the specification or in accordance with the manufacturer's instructions. Cement and sand shall be mixed in a dry state and then wetted and mixed thoroughly to obtain the required consistency, including machine mixing if desired by the Engineer. The mortar shall be consumed within half an hour of mixing. Any mortar for plaster, which is partially set, shall be rejected and removed from the site. Machine mixed mortar shall be prepared in an approved mixer as approved by Engineer-in-charge. Mixing for 1-1/2 to 2 minutes is normally sufficient. Only cement sand mortar shall be used in the plastering works. Cement mortar for plastering shall have a mix in the proportion of 1 part of cement and 3 parts of sand by volume unless otherwise specified in the schedule of quantities.

19.3.5 PREPARATION OF SURFACE

All joints in the masonry 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. Surface on which plastering is to be applied shall be clean and free from all dust, loose materials, grease etc. and be well wetted for at least 6 hours before plastering. Brick/ block work shall be brushed down with a steel wire brush to remove all loose dust from the joints and thoroughly washed with water. All laitance shall be removed by chipping and roughening from concrete surfaces, which are to be plastered.

19.3.6 APPLICATION OF PLASTER

In all plaster work, mortar shall be applied with somewhat more than the required thickness and well pressed into the joint and on the surface and rubbed and levelled with a flat wooden rule to give required thickness. Plaster, when more than 15 mm thick, shall be applied in two coats, a base coat followed by the finishing coat. Thickness of the base coat shall be just sufficient to fill up all unevenness in the surface. No single coat, however, shall exceed 12 mm in thickness except in foundation / plinth work. The lower coat shall be thicker than the upper coat. The overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The under-coat shall be scratched or roughened before it is fully hardened to form a

mechanical key. The method of application shall be “thrown on” rather than “applied by trowel”.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150mm square or wooden screed 15 mm wide and of the thickness of the plaster shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the contractor shall, without any extra cost to NPC, make up any irregularity in the brickwork with plaster. All vertical edges of brick, pillars, door jamb etc. shall be chamfered or rounded off at no extra cost to NPCIL as directed by the Engineer. After the plastering work is completed all debris shall be removed and the area left clean. All corners must be finished to their true angles or rounded. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

19.3.7 CURING

All plastered surfaces after laying shall be cured for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

19.3.8 FINISH

In any continuous face of a wall, finishing treatment of any type should be carried out continuously and day break made to coincide with architectural break in order to avoid unsightly patches at junctions.

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.

19.3.8.1 STANDARD FINISH

Where punning is not 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.

19.3.8.2 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.

19.4 RUBBLE SOLING FOR FLOORS ON GRADE

The rubble shall be of approved quality. Thickness of soling shall be as shown on the drawings/schedule of quantities. The rubble soling shall be carefully hand packed as close as possible and bedded firmly with their largest side placed vertical, the broader faces downward, the smaller surface at top and voids and interstices filled in solidly by wedging with hard chips and small stones but of largest size possible to fit interstices finished with cement sand mortar 1:10 min. and thickness as indicated on drawing.

No stone shall be less than 80 mm in thickness or less than 2.8 kg in weight or more than the depth of soling in thickness and not to exceed in length or breadth twice its thickness.

When a sufficient length of soling has been laid, this shall be compacted with a three wheeler power roller and the surface shall be evened by blinding uniformly with sand not exceeding 10% silt during rolling. Places inaccessible to the roller may be compacted by hand with log hammer or mechanical tampers or by hand rollers subject to the approval of the Engineer.

19.5 EXPANSION JOINT FILLER

Standard heavy density expanded polystyrene of minimum density 35 kg/cu.m and conforming to IS:4671 shall be supplied in sizes and used in accordance with drawings. The thickness of the material shall be as indicated on drawing. Adhesive if any required to fix expansion joint filler to all forms of structure shall be supplied by the Contractor. A sample of material shall be approved by the Engineer before it is used on site. Installation shall be carried out as directed by the Engineer. The polythene sheet used for wrapping shall be minimum 250 micron thick and shall be got approved by the Engineer.

19.6 EXPANSION JOINT SEALING

Expansion joint shall be provided with PVC water stop / hot dip galvanised strips with class 2 zinc coating of width and thickness as stated in the schedule of quantities/ as shown on drawings or as approved by the Engineer. The strips shall be bent to shape indicated on the drawings and connected properly to the structure. Expansion joints shall be continuous and where two or more strips meet they shall be lapped 75 mm and brazed or welded as the case may be. Welding shall be carried out by qualified welders and shall be subject to non-destructive testing as directed by the Engineer. For the purpose of measurement, the laps provided shall be neglected.

19.6.1 G.I WATERSTOPS

The work to be done under this specification comprises the supply and delivery of Galvanized Iron water stops and accessories for the Main Plant Civil Works, all in accordance with the requirements of this specification. The Intent of this specification is to provide water stops completely in accordance with this specification ready for installation. Installation of material will be done by the contractor.

APPLICABLE CODES

IS: 277: 2003 Specification for Galvanized Steel Sheets (Plain and Corrugated)

DESCRIPTION

The GI Water stops shall be of 3.15 mm thick fabricated in accordance with IS: 277 (latest edition) and galvanized for dry film thickness of 60-100 micron

19.7 BITUMASTIC JOINT SEALING COMPOUND

Bitumastic joint sealing compound conforming to Grade A (normal) of IS: 1834 (latest Edition) shall be supplied and used in accordance with drawings. The size of groove to be sealed shall be in accordance with drawings/schedule of quantities. A sample of material shall be approved by the Engineer before its use on site. Work shall be carried out as per manufacturer's instructions or/and as directed by the Engineer.

19.8 BITUMASTIC PAINT FOR ISOLATION JOINTS

Bitumastic Paint Conforming to IS: 9862 shall be supplied and applied by the Contractor. Two coats of paint shall be applied over surfaces to form isolation joints. Painting shall be performed in accordance with the manufacturer's instructions or /and as directed by the Engineer. A sample of material shall be approved by the Engineer before it is used on site.

19.9 NEOPRENE & COPPER SHEET

Neoprene & copper sheet shall conform to the following specifications and a sample of material shall be approved by the Engineer.

19.9.1 NEOPRENE PAD

The pads shall be 100 percent Chloroprene compound known as "Neoprene" and shall be cast in moulds under pressure and heat. Compositions for pads shall meet the requirements listed below.

The pads shall meet the following physical test requirements:

PROPERTY	REQUIREMENT	ASTM TEST METHOD
Durometer (Type A), Hardness	60±5	D 2240
Ultimate Tensile PSI Min.	2500	D 412
Ultimate elongation at Break Min. %	350	D 412

HEAT RESISTANCE: 70 HRS. @ 212° F in AIR Change in Durometer Hardness , %Max Change in Tensile, %Max. Change in Elongation, % Max.	 +15 -15 -40	 D 573
COMPRESSION SET 22 HRS. @ 212° F,% Max	35	D 395 Method B
Compression set induced in vulcanized Rubber During Exposure to high energy Nuclear Radiation, % Max.	25	ASTM D-2309
OZONE RESISTANCE 100 pphm ozone in air by volume, 20 % strain 100 ± 2 ° F, 100 hrs, mounting procedure ASTM D 518 Procedure A	No Cracks	D 1149
TEAR RESISTANCE, (kgf/cm), Min.	45	D 624
LOW TEMPERATURE TEST Brittleness at - 40° F	Pass	D 746 Procedure B

Neoprene sheet shall be placed and cut suitably to shapes and sizes as mentioned in the drawings. Brazing shall be carried out as per manufacturer's specifications and by qualified persons, subject to testing as directed by Engineer.

19.9.2 COPPER SHEET

Copper strips of material type-"O" (annealed) conforming to IS: 14811 shall be used.

19.10 POLYETHYLENE SHEET

Polyethylene sheets 250 micron thick conforming to the IS 2508 shall be supplied and used to form separation joints. A sample material shall be approved by Engineer before its use at site.

19.11 SLIDING COVER STRIP

At the expansion joints, members like columns and beams have been duplicated on either side of the separation and provided with embedded parts for installing the sliding type cover strip to accommodate any building block movement. The cover strip shall be provided both at vertical and horizontal points in accordance with details shown on drawings. The strip element shall be of mild steel, plain or chequered as indicated, and of size and thickness shown on drawings and schedule of quantities and rates. The fixed edge shall be suitably attached to the embedded bearing plate, as provided, by plug weld or tap screw as shown or as instructed by the Engineer. At the sliding edge, the sliding surfaces of the embedded plate provided and underside of the cover strip shall be machined smooth. Adequate care shall be taken not to cause any damage to the strip.

19.12 **Aluminium Door, Windows and Partitions**

The type and construction of Aluminium Doors shall be similar to steel doors.

These (doors, windows and partitions) shall be of sections extruded from aluminium alloy conforming to IS: 733 . Door skin plates and stiffeners shall have a minimum 3 mm thickness. All sections shall be manufactured by Indian Aluminium Co. Ltd., All doors shall be insulated with spun mineral wool insulation for sound deadening. Doors, frames, mullions, transoms and all other exposed aluminum sections shall be alumilited, 0.015mm thickness, satin finished in natural aluminium colour. A protective transparent coating shall be applied to the sections before shipment from the factory.

Aluminium frame work for glazed partitions with aluminium glazed access doors shall be as shown in drawings, excluding supply of glass and glazing. All sections shall have a minimum 3 mm thickness and alumilited as specified above.

Aluminium door shutters, windows and partitions shall have mechanical joints with necessary fasteners.

Portions of aluminium frames which come in contact with masonry construction shall, before shipment from the factory, be protected with a heavy coat of alkali resistant, bituminous paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines. Work on the above, other than described, shall be carefully fitted and assembled with name joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. All drilling of structural supports to install aluminium doors and frames shall be done and included in the work. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

All work shall be erected in plumb and true to line and ready for building into masonry or other types of wall construction. Doors and frames, not properly installed or being out of line or distorted shall be reset and corrected by the contractor at his expense.

Hardware and fixtures shall be as specified under "Door/Window Schedule". All hardware shall be heavy duty and the door closers of extra heavy duty type. All exposed metal shall be satin finished aluminium. All locks shall be cylinder type. All hardware shall be approved by the Engineer before installation.

19.12.1 **Fabrication Drawings**

Before starting fabrication of all metal doors windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. Only after approval of drawings, the fabrication shall be started.

19.12.2 **Workmanship**

Workmanship shall be of best quality, free from any flaws and defects. Samples of each type shall be submitted and approval of the Engineer taken by the Contractor, before starting bulk manufacture.

19.12.3 **Transporting**

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.

19.12.4 **Sliding Door (Supply and Installation)**

19.12.4.1 Scope

This specification covers the design, supply of materials, fabrication, delivery and erection of MS sliding doors including all accessories as herein after specified.

19.12.4.2 General Description and Construction Details

The M.S. sliding doors shall be best quality adhering to the dimensions and details shown on drawings and schedule and as directed by the Engineer.

The sliding shutter shall be made of MS sheet steel panel of 16 gauge with siffeners made of 14 gauge MS, bent sheets of sizes & shapes as shown in the drawing.

The Heavy duty CI bracket shall be fixed to the lintel by means of coach screws of proper strength but of size not less 6mm diameter with length and spacing as given in the drawing.

The Standard Track/roller guide at top shall be supported on CI bracket at spacing not more than 1500 mm. The guide shall consist of Heavy duty 4 roller trolley fixed to the shutter by standard nut and bolt assembly of diameter not less than 5 mm.

The bottom guide shall made of MS section & it shall be fixed in the floors. This guide shall have 12 mm dia MS anchors of shape and spacing as shown in the drawing welded to it. 4 nos ball bearings16 dia ,with 16 dia stainless steel pin shall be fitted at bottom of each sliding leaf of the door.

The sliding shutter shall be provided with recessed handles and lock of approved make lockable on both sides. Each sliding leaf shall also have tower bolt.

The entire assembly of door shall be such as to have smooth & easy operations by a single person.

19.12.4.3 Erection

The doors shall be erected complete with all necessary hardware, operating mechanisms, equipment, wiring etc. complete, to suit sizes of openings. Upon completion, doors shall be in best operating condition. All installation and erection work, shall be done in accordance with the manufacturer's specifications. The Contractor shall arrange to have at no extra cost to NPCIL, the services of the manufacturer's Supervisor during erection. Any drilling to or cutting of concrete, masonry etc. shall be made good after erection of shutters.

19.12.4.4 Paint and Finish

Shutters shall be painted with one coat of red lead or zinc chromate primer in shop. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat. The doors shall be given final coats as given in the schedule and/or as directed by the Engineer.

19.13 STEEL DOORS AND WINDOWS

19.13.1 DOUBLE PLATE FLUSH DOORS

a) Double plate flush doors shall conform to IS: 4351 and shall be made from best quality 18 G galvanised mild steel sheets and shall be of hollow metal construction 45mm thick. Door frames shall be from the best quality 16 G pressed steel sheets. All doors shall be insulated with spun mineral wool / polyurethane foam insulation for sound deadening. All hollow metal doors shall be flush type as shown on drawings and spot welded to reinforcing members both vertically and horizontally. Reinforcing members shall be from steel sections spaced not over 150mm apart and shall extend for the full height of doors. The members shall be strictly as shown on drawing and/or as instructed by the Engineer. The doors to be provided shall be as per the drawings and shall be as per the approval of the Engineer. Generally, the doors frames shall be 45mm x 45mm x 6mm MS angle sections, shutters made of 43mm rolled steel channel section framework with stiffeners of 40mm x 40mm x 3mm M.S. angle section spaced approximately 45cms c/c, skin plate of one face of the shutter welded to the frame and stiffeners and the other face fixed with machine screws after inserting insulation material, all other details remaining as per the drawings and specifications. The mounting of the door shutters shall ensure leak tightness.

b) Built in louvers shall be stationary inverted ‘V’ blades and fabricated from 20 G cold rolled carbon steel sheets conforming to IS: 513. They shall be of sizes indicated in “Door Schedule” and completely installed in doors. Doors with vision panels shall have the openings formed into the face sheets so that no glass frame is required.

c) All bolts, counter-sunk screws, adjustable, fixing lugs, sleeves, chips etc. shall be provided for proper anchorage and support.

d) Doors and frames shall be fitted and reinforced for all hardware from templates.

e) Wherever required, provisions shall be made for fixing louvers (made of 16 G steel sheets) and/or 6 mm thick sheet glass, as shown on drawings. Glazing beads where required shall be from 20 G steel and shall be removable.

f)The steel doors shall be provided with 6 mm thick clear sheet glass vision panel of 240 mm x 340mm in each leaf.

g) The finished work shall be up to the satisfaction of the Engineer.

19.13.2 DOOR THRESHOLD

Wherever required, thresholds shall be provided as shown on drawings or schedule. Doors without threshold shall have bottom tie of approved type. Finished overall dimensions for doors shall conform exactly as shown on drawings.

19.13.3 STEEL WINDOWS, SASHES, VENTILATORS ETC.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown in the on drawings. The details as called for in the above specifications shall be applicable for coupling mullions, transom, weather bars, pivot arrangement for ventilators, fixtures and fastening etc.

All Finished overall dimensions shall conform to exactly as shown in the drawings. Individual members shall be of adequate strength and sections as per relevant IS codes and as shown in the drawings. All welds shall be dressed flush on all exposed and contract surfaces.

Where composite unit openings are shown in the drawings, the individual window units shall be joined together with requisite transoms and mullions and/or as shown in drawings. All projected out window 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 17/32” X 7/16” X 3/32” unless otherwise shown on drawings.

19.13.4 FITTINGS FIXTURES AND HARDWARE

Hardware and fixtures shall be as specified in “Door Schedule" and of best quality from the manufacturer as approved by NPCIL.

The Hardware and fixtures shall be of heavy-duty type and the door closers of extra heavy-duty type. Finish shall be dull bronze finish and/or anodised aluminium as specified in “Schedule of Items”, except butts for interior and door closers. Interior butts shall be prime coat finish and door closers sprayed bronze.
The Contractor shall submit samples of each type of hardware and fixture to the Engineer for approval. The approved samples shall remain with the Engineer for comparing with the actual supply and only those conforming to the approved samples shall be accepted.

The Door closers shall be from approved manufacturer with ISI certification and manufactured and installed as per relevant IS Codes and good Engineering practices.

19.13.5 SHOP PAINT

The shop paint shall be best zinc phosphate primer of approved manufacturer. Before assembly, all surfaces shall be given a coat of rust resisting paint. After assembly, all exposed surfaces shall be cleaned and smoothened and two coats of approved make enamel paint shall be uniformly applied over the surface.

19.13.6 INSTALLATION

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 latest edition, and as shown in the drawings and 'DOOR SCHEDULE'. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvres etc. including transom and mullions for composite units in respective places as shown in then drawings. Keeping proper lines and levels, and in approved workman like manner. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. Care shall be taken to see that framework is not loaded with the weight of masonry or used for securing scaffolding or other temporary staging. Temporary struts may be fixed across the widths preventing sides bulging inwards, which should not be removed till brickwork is set. Care shall be taken to protect the hinges from getting embedded in the mortar while filling the gap between the frame and the masonry opening. If necessary, 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 without any extra charges and finished as per original, after installation.

After installation of steel doors, windows etc. all abrasions to shop coat of paint shall be retouched and made good with the same quality of paint used in shop coat. Rates quoted shall also include minor rectification at site if required such as welding of fixtures, making screw holes and providing screw and rectification of dents formed in the doors and shutters.

19.14 FIRE PROOF DOORS

19.14.1 SCOPE

The work under this section shall include supply and/or erecting and installing fireproof doors as shown in approved manufacturer's drawing with all material complete.

The scope of work shall also include assembly and erection of composite types of fireproof doors. Supplying and/or fixing of all door accessories and hardware and are also included in the scope.

The fire doors shall be single / double leaf fire rated hollow galvanized MS pressed

steel flush doors conforming to BIS : 3614 (Part-1), along with frame at all elevations, with or without removable panels and with or without panic bar having fire rating as approved. The Fire doors shall be of galvanised MS sheets for frames and leaves, mineral wool / PUF/ any other fire retardant insulation material, mastic caulking and grouting the frame, reinforcing and insulating the shutters with fire retardant material including heavy duty SS hinges, thresholds, fittings complete with frame, fittings, fixtures, handles, aldrops, latches, necessary access control hardware, necessary gaskets, drop seal, smoke seal, etc for air tightness. The vision panel shall be of borosilicate float glass or approved equivalent of size 240 mm x 340 mm or as specified in drawing with same fire rating including necessary beading, mastic cement, cleaning and also all hardware as per door schedule including one coat of approved primer and two coats of approved fire resistant / intumescent paint as necessary as per drawings, door schedules and specifications.

All the doors shall have provisions for installation of access control devices such that these devices if installed at a later date shall not impair the basic functions of the door as a fire barrier. These provisions shall be in the form of providing a separate steel plate of approved dimensions of the same material as the parent door, fixed to the main door at an approved location.

The fire rating of the door shall be clearly embossed on the doors.

The testing of Fire proof doors shall be carried out as per BIS:3614 Part-II standards for approved fire rating, for full size door with vision panel and all fittings and fixtures shall be conducted at approved laboratory for 3 nos. of doors. One door shall be tested from the first lot before shipment to site and remaining at random from balance supply.

19.14.2 DRAWING

Fire proof doors shall be as manufactured by manufacturer qualified by NPCIL. Before starting fabrication of all fire proof doors the contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

19.14.3 APPLICABLE CODES

Following are some of the important I.S.Codes as relevant to this section:

I.S: 3614 - Fire doors
I.S: 1038 Steel door, windows and ventilators
I.S: 4351 - Steel door frames
I.S: 1081 - Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

19.15 ROLLING STEEL SHUTTERS

19.15.1 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of rolling shutters with motor drives and/or manual operation including all accessories as herein after specified.

19.15.2 GENERAL DESCRIPTION OF CONSTRUCTION DETAILS

The doors shall be of best quality rolling steel service doors adhering to the dimensions and details shown on drawings and schedule.

a) Slats for shutter shall be made from tested bright cold rolled, annealed M.S. Strips, not less than 18 gauge thickness, machined, rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm centres running horizontally flexible connected with vertical links spaced not more than 200mm centres. Alternatively, rolling grills shall be made from perforated slates of approved design reinforced with 6mm dia. rods.

c) End locks shall be heavy type and 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 6mm thick for external shutters. When shown on drawings a flexible weather strip shall be applied to make tight contact with the floor.

e) Steel guides shall be of angle frames secured to the metal frames or masonry at openings. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified in IS: 875 for the double rolling steel shutters a central guide which is movable by sliding by mechanical arrangement shall be provided. Material for guide channels shall conform to IS: 513 latest editions.

f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of $1/360^{th}$ 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, suitably reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision to securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as desired by the Engineer.

i) Power unit shall be suitable for 3 phases, 50 cycles 400 Volt AC power supply and shall be higher 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 minute. The electric motor shall be 3-phase 415V AC, 50Hz. TEFC enclosure complying with NPCIL

specifications PB-E-293. 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 of 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 grave cast iron; machine moulded from machine cut patterns.

l) Bracket plate thickness shall be minimum 3.15mm.

19.15.3 OPERATION

19.15.3.1 MANUALLY/ MECHANICALLY OPERATED SHUTTERS

Manually operated shutters shall be easily operable by one person. In general, manually operated shutters shall be push pull type for openings up to 9 sq. m. 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.

19.15.3.2 POWER OPERATED SHUTTERS

These shall be operable from a push button station conveniently located beside the door or as shown in the 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. Limit switch shall also be included. The power drive shall be so designed that electric motors may be removed without affecting operation by means of an auxiliary endless chain gear operator.

Motor driven shutters shall have the following compulsory operation system. Mechanism shall be galvanised and of tested quality and shall be guaranteed to prevent chain from leaving wheel and of sufficient length to terminate approximately 600 mm above floor. Reduction gear shall be extra strong, cast without teeth for machine-finished pattern. Necessary lubrication shall be provided.

19.15.4 ERECTION

The shutters shall be erected complete with all necessary hardware, operating mechanisms; equipment, wiring etc. complete, to suit sizes of openings. Upon completion, shutters shall be in best operating condition. All installation and erection

work, shall be done in accordance with the manufacturer's specifications. The Contractor shall arrange to have at no extra cost to the owner, the services of the manufacturer's Supervisor during erection. Any drillingor cutting of concrete, masonry etc. shall be made good after erection of shutters.

19.15.5 PAINT AND FINISH

Shutters shall be painted with one coat of zinc phosphate primer and two coats of approved synthetic enamel paint unless specified otherwise.

19.15.6 ELECTRICAL WORK

All electrical work shall be in strict accordance with the latest Indian Electricity Rules or other approved codes as specified by the Engineer**.**

19.15.7 SHOP INSPECTION AND TEST AT MANUFACTURER'S WORK

After completion of the manufacture of different components of the rolling shutter, drive and other components/ accessories of the rolling shutter, arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

If desired by the Engineer tests shall be carried out at the manufacturer's works in accordance with the approved standards in the presence of the Engineer. Four copies of all the test certificates shall be submitted for approval, if required by the Engineer.

19.15.8 ACCEPTANCE TEST AT SITE

After the equipment has been installed at site the contractor shall carry out performance tests to the satisfaction of the Engineer, after which the shutters shall be accepted. The doors shall be smoothly operable under all ambient conditions. All controls and locking devices shall have fault free performance.

19.15.9 DRAWINGS

The manufacturer / supplier of the rolling shutters shall be got approved by NPCIL before carrying out the work. Prior to fabrication of rolling shutters, the contractor has to measure exact size of the structural opening at site. Fabricated door shall suit to the actual structural opening at site. The Contractor then shall prepare necessary drawings/ detailing of the rolling shutters as per specification, which they intend to supply and seek prior approval of the Engineer. The contract drawings to be furnished by the Contractor shall include but not be limited to the following:

a) Foundation and anchorage drawings for the equipment and drive and their auxiliaries with similar detailed drawings for other equipment.

b) Dimensioned assembly and sub-assembly drawings showing plans and sections of the equipment, instruments and safety devices etc. clearly indicating limiting

dimensions, if any.

c) Complete assembly drawings wiring and connection diagram for all instruments, gauges and controls.

19.15.10 GUARANTEE

The design of the rolling shutter shall be made for withstanding a wind pressure of 150 kg/m2. The Contractor shall give one year's guarantee against operational and material defects and for safety against the design wind pressure.

19.15.11 APPLICABLE CODE

IS: 6248 - Metal rolling shutters and rolling grills.

19.16 CHAIN LINK FENCING AND DOOR

19.16.1 SCOPE

This specification covers the fabrication and installation of wire-link fencing and doors with necessary hardware.

19.16.2 GENERAL

The Fencing shall be constructed of M.S. pipe/ angle frame with welded wire-mesh cladding.

The chain-link doors shall have either single or double shutters of sizes as indicated in the 'Door Schedule'.

The door shutters shall be constructed of M.S. angle frame with welded wire-mesh cladding. The door frame shall be made of M.S. angles built in the wire link partition or in the brick masonry.

19.16.3 SHUTTER FRAME

The frame for door shutter shall consist of two vertical and three horizontal members securely welded together. The shutter frame shall have pivoted arrangement for swing.

19.16.4 WIRE LINK

Welded wire mesh of 50mm x 50 mm with mesh made of 3mm diameter from standard manufacturer shall be used. The mesh shall be made from high tensile wires welded at every intersection. The welded wire mesh shall be positioned inside the angles of the framework. The wire mesh shall be properly stretched and welded to the angle frame.

19.16.5 DOOR FRAME

The door frame shall be made of 80 NB GI Pipe and M.S. angles with necessary provisions to revive hardware. The finished work shall be strong and rigid, neat in appearance and free from defects. Doors shall not have more than 6 mm clearance at jambs & head and not more than 3 mm clearance at the meeting stile edges for pair door.

19.16.6 INSTALLATION

Door frames and shutters shall be assembled and installed such that frames and doors are set plumb, square, level, and at their proper location. All necessary hardware including hasp and staple for locking, pull handle, etc. shall be furnished. The frame shall be securely anchored with hold fasts at brick masonry openings.

19.16.7 CLEANING AND PAINTING

All welds shall be dressed flush on all exposed and contact surfaces. Steel frame members, wire-mesh and welds shall be cleaned of all rust, scale, grease and other foreign matter and then given a prime coat of zinc phosphate primer.

The finished work shall be to the satisfaction of the Engineer-in-charge.

19.17 FLOORING, SKIRTING AND DADO

19.17.1 SCOPE

This specification shall include furnishing of all labour, materials, and equipment, necessary to complete the different types of flooring work as shown in the drawings. Work under this section shall include:

i) Indian Patent Stone Floor (IPS)
ii) Concrete floor with metallic hardener
iii) Tiled floor (with underbed)
iv) Glazed tiled flooring and dado
v) Vacuum dewatering floors with ironite finish
vi) Cement Skirting and dado In-situ
vii) Precast tile skirting
viii) Ceramic tile flooring and dado
ix) PVC tile floor
x) Acid and/or alkali resistant floor
xi) Kota stone flooring and skirting
xii) Vitrified polished tile flooring and skirting
xiii) Granite flooring and dado/ cladding
xiv) PVC Electro static conductive flooring
xv) Precast cement concrete interlocking paver blocks

Any integral finish to the base concrete indicated in drawing or schedule like finishes F1, F2 & F3 for formed surfaces and finishes U1, U2 & U3 for unformed surfaces shall be deemed to have been provided in the structural slab.

19.17.2 PREPARATION OF BASE

For all type of flooring, skirting and dado work, the base cement concrete slab or the masonry surface shall be cleaned of all dirt with water and hard brush. If required the base surface shall be hacked or otherwise roughened to obtain a good bond. The surface shall be clean, free from grease, oil, dust, loose particles, etc. and thoroughly soaked with water to prevent absorption of mixing water from the base course. Before placing the under bed, and excess standing water shall be mopped out. Before laying the flooring, skirting or wall finish, approval of the Engineer shall be obtained as to the acceptability of the base.

19.17.3 INDIAN PATENT STONE (IPS)

a) Preparation of base shall be as specified above. The patent stone floor unless otherwise stated shall have a minimum thickness of 40mm. The under-bed shall consist of cement concrete with 10mm down, clean, well-graded, hard approved stone chips and clean, sharp, coarse sand. Elongated or thin flake like fragments of stone shall be avoided. The proportion of the mix shall be 1 part cement, 1parts sand and 2 parts stone chips by volume.

b) Water content shall be minimum, sufficient to give a workable consistency, which will allow finishing without excessive trowelling. Generally water cement ratio of 0.4 should suffice. The floor shall be cast in panels not exceeding 5 sq.m. in area and no side more than 2.5m long. Panels shall be made using aluminium strips. The casting sequence shall be in a chequered board fashion, no two adjacent panels being cast before the contraction of the previous one has taken place. The edge of each panel into which the floor is divided shall be supported by flat bars of steel or wood duly oiled to prevent sticking. The bars shall be removed before filling in adjoining panels. At least 48 hours shall elapse before the concreting in the adjacent bay is commenced. After laying, the under bed shall be levelled, compacted and brought to proper grade with a screed or float.

c) Then a layer of minimum 6mm thickness shall be laid over the green under bed and trowelled smooth with a mixture of cement and sand (1:1 by volume). The under bed and topping shall be completed in one operation.

d) The topping shall be trowelled smooth to the satisfaction of the Engineer. Any marks of trowel shall be mopped with a soft cloth to give a clean, even and smooth surface.

e) Where specified on drawings the thickness of the under bed shall be adjusted to make the total thickness as shown in the drawings.

f) When polishing is to be done, if specified in the drawings and/or “Schedule of

Quantities" it shall be done in a manner as approved by the ENGINEER.

19.17.4 CONCRETE FLOORING WITH METALLIC HARDENER

19.17.4.1 GENERAL

The specified hardening system shall be applied by a specialist applicator certified by the manufacturer of the system strictly as per the written method statement submitted by the manufacturer.

a) THICKNESS

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth over 28 mm thick concrete base. Total thickness shall be 40 mm thick.

b) MATERIAL

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand, soluble alkaline compounds or other injurious materials. Actual samples shall be tested prior to use at site.

c) MIX

Proportion of metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction, 1 part metallic hardener shall be mixed dry with 4 parts of cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to two parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) LAYING

The concrete floor shall be laid as per the specification of Concrete work and levelled up to 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.

12 mm thick finish shall be laid while the concrete under bed 28 mm thick is still very green within 3 hours of laying the latter. The finish shall be of uniform thickness and free from trowel marks, pin hole, etc. The topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. The surface shall be smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

19.17.4.2 SUBSTRATE CONDITION

The grade of concrete for substrate should be preferably M20. At the time of construction of floor, as soon as the plasticity of the mix is reached, the surface of the

freshly poured concrete shall be smoothened out and shall be flattened out with the vibrating straight edge. This concrete should be dense and compact which could be obtained by adding plasticizers like Plastiment BV 40 or equivalent (0.3% by weight of cement or it may vary due to site condition). It is preferable to use a mechanical trowel for smoothening operation.

19.17.4.3 **LAYING**

The ready mix non-metallic hardener compound shall be spread over the newly laid smooth concrete surface at a stage when a nail mark of 3-4mm shall be obtained at standard pressure. The spreading shall be done by hand or with a suitable apparatus @ approximately 6.0 kg/m² for a thickness of 3 mm surfacing.

Time should be given till the mixture has been uniformly moistened by the surface water contained in the green concrete. The surface shall be smoothened out with a mechanical trowel which shall be maintained perfectly flat, operating at a low speed.

Immediately, after the flooring surface is finished, it shall be protected from rapid drying. As soon as the floor is hardened sufficiently, it shall be kept moist for at least 3 days by wet gunny bags.

19.17.5 VACUUM DEWATERING SYSTEM OF FLOORING WITH IRONITE FINISH

19.17.5.1 GENERAL

a) Thickness, material and mix shall be as per specification on “concrete flooring with metallic hardener” included earlier in this chapter.
b) Grading of constituents of concrete and slump shall be as per manufacturer’s recommendation.

19.17.5.2 JOINTS

The concreting shall be done in bays as recommended by the manufacturer. In absence of which bays of 20 M x 20 M shall be followed. Aluminum strips shall be provided for separation of panels.

19.17.5.3 LAYING AND WORKMANSHIP

All arrangements including installation of guide rail, positioning of pipes for water and drainage, shall be placed either by pump or manually. Poker vibration and tremix surface vibrators are used sequentially to obtain proper leveling and compaction. Suction mat shall be used with proper arrangement of suction holes to vacuum pump, draining line, etc. so as to achieve recommended pressure by the manufacturer on the concrete surface. Proper care shall be taken to drain out excess water from concrete. Normally concrete shall be subjected to suction for a period of 1 to 2 min per centimeter thickness depending on the particle shape of the mix. Immediately after vacuum dewatering the surface is power floated with skim floater. To obtain smooth surface

skim floater fitted with troweling blades shall be used. The floating and troweling operation shall be completed within one hour for concreting.

19.17.6 TILED FLOOR WITH UNDERBED

19.17.6.1 GENERAL

The tiles shall be (a) plain cement tiles (b) plain coloured tiles, and (c) terrazzo floor tiles, conforming to IS: 1237 – latest edition and of dimensions as shown of under bed drawings. The wearing face of these tiles shall consist of plain or coloured cement for items (a) and (b) and white or coloured cement and marble chips for item (c), size, colour and proportions of which shall be as per instructions of the Engineer. All angles of tiles shall be right angles, and the colour and texture of the wearing face shall be uniform throughout its thickness, which shall not be less than 6mm. Colour shall be non-fading and lime-proof and the face of tiles shall be plane, free from cracks, depressions and projections and reasonably parallel to the back face.

The portion of cement to aggregate in the backing of tiles shall not be leaner than 1:3. Colouring material wherever used shall not exceed 10% by weight of cement used in the mix.

19.17.6.2 MATERIALS AGGREGATES

a) Aggregates used for mortar for fixing the tiles shall conform to IS: 383 – latest edition.

b) The cement used for fixing the tiles and cement grouting shall conform to IS: 12269 latest edition – or white cement of approved quality.

c) Pigments incorporated in mortar or used for Pigments grouting shall be stable and non-fading.

d) Water shall be clean and free from oil, water acid, alkali and organic or vegetable matters.

e) Aggregates used for the terrazzo topping aggregates shall be marble chips of size varying from for 1mm to 20mm. The proportioning of chips of terrazzo various grades shall be as per directions topping of the Engineer. Marble powder used for the topping shall pass through IS Sieve No. 30.

f) The delivery of tiles shall be so arranged as to minimise handling. Adequate precautions shall be taken to prevent accidental damage to tiles while unloading. The tiles shall be stored under cover to prevent exposure to dampness, sun, rain, accidental injury or straining.

19.17.6.3 LAYING AND WORKMANSHIP

a) Preparation of the base shall be as laying specified under 1.28.2 above. The surface shall be thoroughly soaked with water after soaking with water, the under bed of

thickness as shown on drawings shall be evenly as smoothly spread. The mortar for under bed shall be composed of 1 part cement and 3 parts sand. The under bed shall be well consolidated and brought to proper grade, to a level below the finished floor level equal to the thickness of the tiles. The tiles shall then be placed before the under bed has set.

b) The tiles shall be soaked in water for 10 to 12 minutes and allowed to dry for the same length of time. The under bed shall be thoroughly moist, and Portland cement shall be hand-dusted over this immediately before the tiles are laid. The tiles shall then be placed upon and firmly pressed on the under bed until exactly even with the finished floor level. The joints shall be carefully grouted and filled with cement grout of the same colour as the matrix of the tiles. The joints shall not be more than 1.5mm wide.

c) The setting of tiles shall be so done that minimum rubbing is required later on. Initial grinding and polishing of tiles shall be done in the shop and the final rubbing and polishing shall be commenced only after the floor as well as the joints have set and done in a manner approved by the Engineer. Chequered or grooved tiles whether plain or terrazzo, shall always be polished by hand.

d) All work shall be cleaned thoroughly and left in an acceptable condition on completion. No harsh abrasive cleaning powders, acid or steel wire shall be used for cleaning the tiles. Curing shall start on the next day after laying and shall continue for 14 days. The entire work of laying, polishing, finishing and cleaning etc. shall conform for 14 days. The entire work of laying polishing, finishing and cleaning etc. shall conform to IS: 1443 latest edition. Tiles shall be selected and used, such that colour of each area of the floor remains uniform.

19.17.7 GLAZED TILE FLOORING AND DADO

19.17.7.1 MATERIALS

The glazed tiles shall be 6 mm thick premium quality tiles conforming to IS 15622 of approved shade and make. The top surface of the tiles shall be glazed with a mat finish of uniform colour and texture and free from flaws, cracks, chips craze, specks, crawling or other imperfections. These shall be sound, true to shape with true and straight edges, non-absorbing and non-fading having a texture, dense and homogenous. The edges and the underside of the tile shall be completely free from glaze so that these may adhere properly to the surface below. The tolerances shall be +1.5mm for length and breadth and +0.5mm for thickness. Before bulk supply, the contractor shall give samples of tiles to the Engineer for approval. Bulk supply shall only be adopted if it conforms in all respects to the approved samples kept with the Engineer.

White cement, sand, pigments and water shall be as specified.

19.17.7.2 HANDLING AND STORAGE OF TILES

The delivery of tiles shall be so arranged as to minimise handling. Adequate precaution shall be taken to prevent accidental damage to tiles while unloading and these shall be

stored under cover in a manner approved by the Engineer.

19.17.7.3 LAYING AND WORKMANSHIP

a) Preparation of base shall be as specified. The under bed as shown in the drawings shall be laid with a mortar consisting of 1 part of cement and 3 parts of clean, sharp, coarse sand. The thickness of the under bed shall be at least 20mm thick for flooring and 10 mm thick for dado or as shown in the drawings. While still green, the under bed shall be deeply scratched. The under bed shall be laid not earlier than 48 hours before commencing to set the tiles.

b) A mortar setting bed 6mm thickness shall be laid over the under bed to make an even and true surface; over which the tiles shall be laid. This layer consists of 1 part of Portland cement, 1 part of lime putty and 3 parts of clean, sharp, medium sand. The under bed shall be thoroughly saturated with water immediately before applying the mortar setting bed. The setting bed mortar shall be applied over such an area as can be covered by tiles before the initial set of mortar. After the mortar setting bed has been levelled, a skin of neat Portland cement shall be trowelled to the mortar setting bed immediately before the tiles are set.

As soon as the mortar setting bed has sufficiently hardened, all tiles shall be firmly secured in place and gently beaten in, with finished surface brought to desired level. When grouting the glazed tiles, special care shall be taken to prevent scratching of the glazed surface. All surplus grout or mortar shall be removed before it has set or hardened and the face of tiles left clean. The completed work shall be free from cracked, broken or otherwise damaged tiles, No joint shall be more than 1.5mm thick. The joints shall be flush pointed with white or coloured cement to match the tile surface and cured for seven (7) days.

19.17.8 CERAMIC TILE FLOORING AND DADO

19.17.8.1 FLOORING

Non-slippery ceramic tile flooring shall be laid using premium quality mat finished 6mm thick ceramic tiles conforming to IS: 15622 in approved size (minimum 300 mm X 300), make and shade. The tiles shall be laid as per approved pattern over 20mm thick cement mortar 1:4 bedding, close jointed & pointed with matching cement slurry using white cement mixed with pigment, finished to levels / slope or plumb as required including cutting of tiles, curing, acid washing etc. all complete as per manufacturer's specifications and direction of Engineer. The quoted rates shall include the provision for covering of floor tiles with PVC sheet over it to protect the tiles laid from painting stains and scratches during various finishing activities.

19.17.8.2 DADO

Ceramic tile dado shall be laid at all the elevations using premium quality ceramic tiles average 6mm thickness of approved size (Min 450mmx300mm), shade and make conforming to IS: 15622. The tiles shall be laid on walls with average 10 mm thick

underbed with cement mortar 1:3 (1 cement : 3 coarse sand) and 6mm thick setting mortar, jointed with white cement slurry with matching pigment and curing, cleaning etc all complete. The final surface shall project at least 6mm beyond the plastering, but in no case shall the total thickness including under bed be less than 20mm. The surface shall be truly vertical and free from any scratched or cracked tiles. The quoted rates shall include the provision for covering the tiles with PVC sheet over it to protect the tiles laid from painting stains and scratches during various finishing activities.

19.17.9 CEMENT SKIRTING AND DADO IN-SITU

a) The height of cement skirting and dado shall be as shown in drawings and/or instructed by the Engineer. Preparation of the base shall be as specified earlier.

b) The mortar for underbed shall consist of 1 part of cement and 3 parts clean, sharp, coarse sand (by volume), mixed with adequate amount of water to make it workable (not too wet) and shall be thrown on the wall. After finishing with a wooden float, a neat cement paste of minimum 3mm thickness (6mm when polished) shall be applied and pressed to be finally finished with English trowel.

c) The total thickness shall be such that the finished surface projects 6mm beyond plastering, but in no case shall the thickness be less than 19mm or as specified on the drawing. The junction with floors and corners shall be rounded to 25mm radius and/or as instructed by the Engineer. Curing shall be done for a minimum period of seven days.

d) If polishing is specified on drawings and/or schedule of items, the surface shall be rubbed and polished as per standard practice approved by The Engineer.

19.17.10 PRECAST TILE SKIRTING

This shall be done exactly in the same way as specified above. The plaster at the upper edge of the dado shall be finished neatly as directed by the Engineer.

19.17.11 PVC TILE FLOOR

This shall include the quality of materials and the general requirements for the installation of different types of tiles manufactured from vinyl resins including cover base set with sticker on concrete or masonry base in the locations shown in the drawings.

19.17.11.1 MATERIALS

a) The type of tile shall be as indicated on the drawings, schedule and/or bill of quantities. Three types of Vinyl floor tile are covered.

i) Type - V

The tile shall be composed of 100% Vinyl from face to back with alkaline resisting

colour pigments and other plastic compounds.

ii) Type VA

The tile shall be of Vinyl – Asbestos consisting of a through blend of Vinyl plastic resins, asbestos fibres, and alkali resisting pigments and fillers from face to back.

iii) Type VL

The tile shall be Vinyl-laminated consisting of a top-wearing surface of solid vinyl permanently fused to applicant, felt cushion backing.

b) Cove base shall be extruded PVC (100% putty) with moulded top-set cover, colour, and the height of the base shall be as indicated on the drawings, schedules, and/or as approved by Engineer.

c) The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or other physical defects which affect appearance or serviceability.

d) All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalies; cleaning against and unusual floor polishes.

e) Samples of tiles and cove base shall be submitted to the Engineer and must be approved before work is started. Samples shall bear the labels stating the colour gauge and manufacturer's name. Colour, designs and sizes shall be approved by the Engineer after submission of samples. The thickness of the tiles shall be as indicated in the Schedule of Quantities.

f) Adhesive and cements shall be furnished as recommended by the manufacturer of the tiles. The adhesive shall have a short during time and long life in addition to toughness.

g) The tiles shall be square n shape and of approved dimensions and shall conform to the requirements of IS: 3461 and IS: 3462. The tolerance in dimensions shall be +1.5mm and in thickness +0.5mm.

19.17.11.2 INSTALLATION

19.17.11.2.1 GENERAL

The tiles shall be kept in the room to be tiled for at least 24 hours prior to laying to bring them to the same temperature of the laying area. The work should not the carried out under high humidity conditions. For air-conditioned space, the flooring shall not be laid until the conditioning units have been in operation for at least seven (7) days. During this period the temperature shall neither fall below 20° C. These conditions shall be maintained during laying and for 48 hours thereafter.

19.17.11.2.2 PREPARATION OF SUB-FLOOR

a) The surface to receive this finish shall be firm, even textured but not too smooth, without undulations and other deficiencies. If an under bed is laid the same shall be cured for at least seven (7) days by keeping it moist and fully dried. Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall be broom clean and free of paint, wax, grease or oil. Cracks shall be filled with crack filler.

b) The layout of the PVC on the sub-floor to be covered should be marked with guidelines. The PVC flooring shall be first laid for trials and approval without using the approved adhesive.

c) The adhesive shall be applied uniformly by using a notched trowel to the sub-floor and to the backside and edges of the tiles and allowed to surface dry. Any adhesive squeezed out through the joints and contaminating the face of the tiles shall be removed immediately. An appropriate solvent shall be used to remove any adhesive that has hardened. The traces of solvents shall be removed and the tiles cleaned before reuse.

d) The tiles shall be laid true, level and even exactly to the approved pattern and close to each other with minimum gap between joints. It is preferable to start laying of the tiles from the centre of the area. The tiles should be lowered in position and pressed firmly on to the adhesive. After laying, the tiles shall be rolled over, in two directions, with a light wooden roller weighing about 5 Kg. to ensure full contact with the underlay. If the edges tend to curl up, weights should be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. Any undulations noticed on the tiling surface shall be rectified by removing and relaying the tiles after thorough cleaning of the underside of the affected tiles. Work should be constantly checked against guide lines in order to ensure that all four edges of adjacent tiles meet accurately. Tiles shall be fitted carefully to and around all permanent fixtures. Borders shall be fitted accurately.

e) A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to take up PVC flooring work after completion of plastering, painting, false ceiling and other decorative works so as to avoid any damage to the flooring.

f) Cove base shall be firmly cemented to the walls and accurately scribed to trim and finish.

g) The exposed edges of PVC tiles are doorways and other locations shall be provided protection against damage by metallic edge strips securely fastened to the sub-floor.

h) When flooring has been laid and fixed, it shall be thoroughly cleaned of surplus adhesive. The flooring shall then be cleaned with a wet cloth soaked in ware soap solution. All scraps, packing materials and debris shall be removed.

19.17.11.3 ACCEPTANCE

Improper application of the adhesive or imperfect embedment of tile in the adhesive as evidenced by ridges in the surface, by lack of even and uniform bearing, by loose bond, or by curled loose edges will be cause for rejection. All such defects shall be remedied to the satisfaction of the Engineer prior to acceptance.

19.17.11.4 GUARANTEE

All work executed under this specification shall be guaranteed free of defects in material and workmanship for a period of one year after completion of the work. Upon written notice of any defect in material or workmanship, repairs or replacements shall be made at no expense to Corporation. Corporation shall, however, arrange for the removal and replacement of all fixtures and equipment attached to the surface on which the work will be done.

19.17.12 ACID AND/OR ALKALI RESISTANT FLOOR

19.17.12.1 MATERIALS

The Acid and/or alkali resistant tile or rolls shall be to true and straight edges, shall be non-absorbing, without stains, non-fading, and obtained from approved manufacturers.

The rolls shall be 3 mm thick Thermo Plastic Polypropylene glass lined and shall be guaranteed to resist acid and alkalies of about 30% concentration. The laying of Acid proof rolls shall be carried out as per manufacturer's recommendation strictly and by a specialised agency.

The tenderer shall specify the characteristics of the tiles or rolls and shall enclose the manufacturer's literature for the same confirming their service ability for both acids and alkalis. The Contractor shall submit samples of tiles or rolls for approval to the Engineer and the bulk supply will only be accepted if it conforms in all respects to the approved samples kept with the Engineer.

19.17.12.2 LAYING AND WORKMANSHIP OF TILES

a) The surface should be levelled, dried, cleaned of dust, and should not be too smooth (sand finish) prior to pasting of PPG roll. The PPG roll should be cut into desired size for pasting. The required quantity of pasting compound should be mixed from the two components. The hardener should be added further in this mixture. The mixture is to be applied to the surface and the back side of the PPG roll after laying the fibre mat as per manufacturer recommendation and pasted by applying dead weight by putting sand bags etc. The pressure may be applied by jacks on the vertical surfaces.

b) Thermoplastic sheets should be welded by using fusion welding technique as per manufacturer's specification.

c) The Contractor shall furnish full details regarding the materials for the different treatments described above pertaining to this flooring work as per manufacturer's specifications, and shall lay and set the rolls properly in full conformation with the manufacturer's instructions. The entire work shall be done in workman like manner to the complete satisfaction of the Engineer.

d) The Contractor shall give a guarantee for the satisfactory life of the floor for a minimum period of one year under operating conditions. All defects appearing within this period shall be rectified to the satisfaction of the Engineer by the Contractor at no extra cost to Corporation.

19.17.13 KOTA STONE FLOORING AND SKIRTING

Kota Stone shall be of best quality and obtained from approved sources. Kota stones shall not be less than 20mm thick for flooring and 20mm thick for skirting or as specified in schedule and shall be cut to the required sizes, as approved by the Engineer. The stones shall have to be machine cut and double machine polished. The edges to be pointed shall be true to line and dressed wherever found necessary to the full depth all round. The stones shall be hard, sound, and free from cracks, veins and other defects and of uniform colour. In case of Kota stones available in different shades, the samples shall be submitted for approval of the Engineer.

19.17.13.1 LAYING AND WORKMANSHIP

Before laying the flooring the surface to laying be paved, shall be thoroughly hacked, cleaned of all mortar scales, concrete lumps, loose materials etc. Unless and until, the surface is approved by the Engineer, the paving shall not be taken in hand. A bedding of cement mortar (1:4) of 20 mm thickness for flooring shall be laid evenly and to the required slopes as directed. The stones shall then be truly and evenly set in a thin paste of neat cement applied to sides, bottom and to the prepared base. The stones shall then be tamped down with wooden mallet until they are exactly in true plane and line with the adjacent stones. All stones shall be extended up to the masonry wall and underside of plaster. The stones shall be close jointed and joints shall be as thin as possible.

The cement that oozes out thorough the joints shall be wiped clean. The joints shall then be pointed with matching cement and finished neatly. The flooring shall be cured for seven (7) days. The entire surface and flooring shall be re-polished with machine to the satisfaction of Engineer.

19.17.13.2 KOTA STONE SKIRTING

Kota stone skirting shall be laid against a bedding of cement mortar (1:3) 12mm thick to the full height of skirting to a true plane, level and plumb. The workmanship shall be similar to flooring. The skirting shall be laid projected beyond the finished plastered surfaces. The continuous horizontal groove at the top of skirting shall be provided as per drawing or as directed by the Engineer. No extra will be paid for grooves. The skirting shall be cured for seven (7) days. The skirting surfaces shall be re-polished with had to the satisfaction of the Engineer.

19.17.14 VITRIFIED POLISHED TILE FLOORING AND SKIRTING/DADO

19.17.14.1 FLOORING

Vitrified polished tiles shall be of premium quality of size 600mm x 600mm of approved make and shade, conforming to IS: 15622 having minimum thickness of 9 mm. The tiles shall be laid in approved pattern over 20mm thick cement mortar 1:4 bedding. The tile slabs shall be close jointed & pointed with matching pigmented white cement slurry and shall be finished to levels / slope as required. Scope of work also includes cutting of tiles to the required size , curing, washing etc. complete with all materials, tools labour etc. all complete as per manufacturer's specifications and direction of the Engineer. The quoted rates shall include the provision for covering of floor tiles with PVC sheet over it to protect the tiles laid from painting stains and scratches during various finishing activities.

19.17.14.2 DADO

Vitrified polished tile skirting/ dado shall be of approved make and shade, conforming to IS: 15622 having minimum thickness of 9 mm. This shall be laid at all elevations in approved pattern laid in skirting over and including on 12 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with neat white cement slurry with pigment of matching shade to match the shade of the tile including curing, cleaning etc. all complete as per manufacturer's specifications and direction of the Engineer..

19.17.15 GRANITE FLOORING AND DADO/ CLADDING

19.17.15.1 FLOORING

Granite slab shall be of 1st quality in approved colour and size (Minimum 600mmX600mm). Granites slabs shall be provided and laid in 20 mm nominal thickness, with inlay for the border as flooring design, laid in approved pattern over base 20 mm thick cement mortar 1:4 (1 cement : 4 coarse sand) and jointed with white cement slurry mixed with pigment to match the shade of the slab.The scope of the work shall also include surface preparation, rubbing, curing, moulding and mirror polishing complete as per manufacturer's specifications and as directed by the Engineer.

19.17.15.2 DADO

Providing and fixing 20 mm nominal thick granite slab of 1st quality as wall cladding with approved colour and size (to cover the entire height of the dado in single piece without any joint and minimum 600mm width) laid in approved pattern over a base of 20 mm thick cement mortar 1:4 (1 cement : 4 coarse sand) jointed with white cement slurry mixed with pigment complete as directed including filling the gaps between the base mortar and granite slab with 1 : 2 cement slurry and making 'V' grooves wherever required, inclusive of stainless steel fisher clamp with expansion bolts at least 2 nos. for each slab wherever necessary, including rubbing, curing and mirror polishing complete as per specifications and as directed by Engineer. Quoted rate shall include

supplying and providing stainless steel clamps as necessary with expansion bolts or any other accessories required to complete the dado work.

19.17.16 PVC ELECTROSTATIC CONDUCTIVE FLOORING AND SKIRTING

19.17.16.1 FLOORING

PVC Electrostatic conductive flooring and skirting 2 mm thick shall be installed over integral concrete floors finish/IPS/ hardonite flooring. The material specification and laying procedure shall be as per NPCIL Specification No. PPE-2273 (latest Rev.)

19.17.16.2 SKIRTING

PVC electrostatic conductive skirting shall be minimum 2 mm thick and shall be supplied and installed at various elevations inside main plant buildings over concrete / plaster surfaces satisfying all the requirements laid down in NPCIL technical specification PP-E-2273. The scope shall include all accessories / material required for installation of the same such as copper grounding strips, welding rods, surface preparation / levelling of floor, adhesive etc. as per requirements and testing at site all complete as per drawing, manufacturer's specifications and direction of the Engineer.

19.17.17 PRECAST CEMENT CONCRETE INTERLOCKING PAVER BLOCKS

Precast cement concrete interlocking pavers blocks shall conform to IS 15658. Paver blocks shall be of M-40 grade and 80mm thick factory made coloured blocks made by block making machine with strong vibratory compaction. The blocks shall be of approved colour and shape. Cement Concrete paver blocks shall be laid in approved pattern over 50mm thick compacted bed of fine sand, filling the joints with fine sand etc. all complete as per manufacturer's specifications and the direction of the Engineer.

19.18 GENERAL PAINTING ON INTERIORS & EXTERIOR SURFACES

19.18.1 SCOPE

a) This specification covers general painting on concrete, plastered and steel surfaces both interior and exterior as shown in drawings, schedules or as directed by the Engineer.

b) The Contractor shall inspect the surfaces of works completed by other agencies 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 and unsatisfactory finishing that results.

c) Before commencing painting, the contractor shall obtain the approval of the Engineer in writing regarding the scheduling 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.

19.18.2 MATERIALS

a) Materials shall be of the highest grade products of well known approved manufacturer 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.

b) All materials shall be subject to inspection, analysis and approval by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade be obtained from the same manufacturing batch.

c) All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

d) All primer coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

e) All unspecified materials such as shellac, turpentine or linseed oil shall be of highest quality available and shall conform to the latest I.S. specifications. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

f) 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.

19.18.3 STORAGE

The contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement and stains. Paints shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Contractor to prevent fire.

19.18.4 PREPARATION OF SURFACE

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted.

19.18.4.1 MASONRY, CONCRETE AND PLASTERED SURFACE

Before taking up painting works F3 finish shall be carried out on concrete surfaces. Plastered Surface shall be wire brushed and sand papered, clean and free of all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaced area shall be treated with minimum one coat of cement primer, which should continue to the

surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below:

a) MILDEW

All mildew surface shall be treated with an approved fungicide such as ammonia wash consisting of 7g of copper carbonate dissolved in 80 ml liquor ammonia and diluted to 1 litre with water, or 2.5 percent magnesium silica fluoride solution allowed to dry thoroughly below the paint is applied.

b) EFFLORESCENCE

All efflorescence shall be removed by scrubbing the affected surfaces with a solution of muriatic acid in water (1:6 to 1:8) and washed fully with clear water and allowed to dry thoroughly.

19.18.4.2 **METALSURFACE**

All metal surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. All steel and iron surfaces, in addition, shall be free from rust. All steel or galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Prime coat for steel work shall, however, be applied by the fabricator. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

19.18.5 PAINTING

Various types of finishing shall be done as indicated in the 'Interior Finish Schedule' and/or as on drawings. The colour shall be in accordance with 'Painting Schedule' or as selected by the Engineer.

19.18.5.1 ACRYLIC PLASTIC EMULSION PAINT

Acrylic plastic emulsion paint shall conform to IS: 15489. It shall be water-based acrylic co-polymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blister. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking blisters or peeling.

Plastic emulsion paint shall be of premier quality conforming to IS 15489. It shall be applied in minimum two coats over a coat of approved primer to interior concrete, plaster & other surfaces after cleaning / scrubbing of the surfaces with wire brushes, soft brushes, sand papers, steel sheet scrappers and mechanical grinder etc. for removing all kind of burrs, imperfections, undulations and other such defects existing in the surface including filling surface imperfections such as holes, dents, cracks by

using mixture of white cement & fine sand (in the ratio of 1:3) to achieve plain & even surface. The scope of work includes spreading of suitable and clean protection covering on all exposed surfaces to protect them from staining. All surfaces surrounding to painted area including window frames & glasses shall be cleaned to sparkling clean condition using suitable thinners, detergents, chemical cleaners etc. under the scope of the item as directed, at all elevations as indicated in the drawings including labour, materials, scaffolding, preparation of the surface, protecting & cleaning etc. all complete as per specification and direction of the Engineer.

All concrete surfaces shall be F3 finished before taking up the painting works. Quoted rates of painting shall include cost of F3 finish. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

19.18.5.2 SYNTHETIC ENAMEL PAINT

Synthetic enamel paint shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS: 2932 & IS: 2933. Glossy synthetic enamel paint shall be used on metal surfaces. Ready mix matt synthetic enamel paint shall be used on wall surfaces.

Synthetic enamel paint shall be of approved make and shade premium quality mat / glossy (as directed). It shall be painted in minimum 2 coats to give an even shade on steel surfaces at all elevations after erection including surface preparation and touch up with zinc phosphate primer wherever required. The scope also includes providing and removing scaffolding, all as per manufacturer's specifications, drawings and direction of the Engineer. The rate shall be inclusive of surface preparation with wire brushing and touch up with zinc phosphate primer.

Synthetic enamel paint shall be applied on properly premiered surface. Subsequently, coat shall not be applied till the previous coat is dry. The previous coat shall be lightly sand papered for better adhesion of subsequent coats.

19.18.5.3 ACID, ALKALI RESISTING PAINT

Acid and alkali resistant paint shall be of approved make and colour conforming to IS: 9862. The paintshall be applied in minimum 500 micron DFT over a coat of approved primer on prepared surfaces of flooring, ceiling and walls and other surfaces at all elevations. The scope of work includes all labour, materials, scaffolding, preparation of the surface, protecting & cleaning etc. all complete as per manufacturer's specification and das per direction of the Engineer. Primer coat shall be as per manufacturer's instructions.

19.18.5.4 POLYURETHENE PAINTING

19.18.5.4.1 GENERAL

Polyurethane painting on concrete and steel surfaces shall be done at locations wherever specified in the drawings. Generally the external surfaces of the specified buildings shall be painted with polyurethane paint after completion of the work.

19.18.5.4.2 SCOPE

The scope of work covered under this specification is supply and application of one coat of primer and two coats of polyurethane finish paint of approved make for total dry film thickness of 125 microns (excluding 75 micron thick primer) on exterior surfaces.

19.18.5.4.3 MATERIALS

a) Primer compatible for PU paint shall have outstanding resistance properties and shall contain a high level of penetrating pigment, which renders superior performance when applied over concrete and it should be compatible when over coated with polyurethane paint.

a) The finish paint shall be two-component air-drying acrylic aliphatic polyurethane coating.

c) Suitable thinner for the above will be as per the manufacturer’s recommendations.

d) Finish paint shall be glossy/ matt finish of approved shade and as specified by the engineer.

19.18.5.4.4 DESCRIPTION

The surface shall be cleaned of dust, loose particles, finished and cured properly. Biological growth if any, accumulated on the surface over the period shall be removed completely. Painting shall commence with application of one coat of 75 micron thick primer and finished with 125 micron DFT of polyurethane paint in two coats. The shade of the finish paint is generally light grey in colour and Contractor shall obtain prior approval of Engineer before commencement of work. Method of painting shall be either brush application or using air less spray equipmentusing a pump with nozzle tip of size 0.33 mm to 0.45 mm and more than 2000 psi pressure.The rate quoted shall cater for both methods.

A) Primer shall be two pack epoxy primer with outstanding resistance properties and shall contain a high level of penetrating pigment which renders superior performance when applied over steel/ concrete having the following properties.

PROPERTY	TEST METHOD	UNIT	ACCEPTANCE VALUE
Density	ASTM D 4052	g/cc	1.09 + 0.05 at 25°C
Mixing Ratio, by weigh	ASTM D 4052	ratio	100(Base): 35(Hardener)
Flexural Strength	ASTM C 580-02	Mpa	35 at 7 days
Tensile Strength	BS 6319, Pt 7	MPa	22 at 7 days
Compressive Strength	ASTM C 579	MPa	70 at 1 Day 75 at 3 Days 80 at 7 Days
Adhesive Bond Strength	ASTM D 4541	MPa	>1.5
DFT of Primer	ASTM D 1005	Micron	75

B) The two component polyurethane paint shall have the following parameters.

PROPERTY	TEST METHOD	UNIT	ACCEPTACE VALUE
Volume of Solids	ASTM D 2697	%	57±3
Pot Life	ASTM C603-90	Min	120 (at 25 deg C) 50 (at 40 deg C)
Mixed Density	ASTM D 4052	Kg/Ltr	1.2 (at 25 deg C)
Mixing Ratio, by Volume	ASTM D 4052		4(Base) : 1 (Hardner)
Touch Dry	ASTM D 1640	Min	90 (at 25 deg C)
Recoatable	ASTM D 1640	Hour	6 – 8 (at 25 deg C)
Final Curing Time		Day	7 (at 25 deg C)
Bond Strength	ASTM D 4541	MPa	>2 (Concrete Failure)
Abrasion Resistance , CS17 wheel	ASTM D 4060	Mg/1000 cycles	<125
UV Resistance	ASTM G 53	Hour	>1000
DFT in two Coats of PU Paint	ASTM D 1005	Micron	125

The acceptance criteria shall be based on Manufacturer test certificate except for Bond & Abrasion Resistance test, which shall be performed (one sample per lot) at independent approved Laboratory at the cost of contractor. The test certificate shall clearly specify the PU material as “Aliphatic”.

19.18.5.5 EPOXY PAINTING ON STEEL AND CONCRETE SURFACES

19.18.5.5.1 GENERAL

Epoxy painting on concrete and steel surfaces shall be done at locations wherever specified in the drawings.

19.18.5.5.2 SCOPE

The scope of work to be performed under this specification comprises of supply and application of heavy duty high build epoxy paint of approved make for painting of concrete and steel surfaces in various buildings and areas specified in the drawing, for walls, ceiling, floors and fabricated structural steel members as per relevant drawing and specifications to the thickness as specified in the drawings including surface

preparation.

19.18.5.5.3 MATERIAL SPECIFICATIONS

For the areas, important from radiological considerations, where decontamination and radiation resistance properties are required, the material shall conform to PP-M-1219 as applicable and as specified in the drawings or decided by the Engineer. This material shall be Polyamide cured two pack epoxy coating in mix and use form.

The areas which are not important from radiological consideration as specified or decided by the Engineer, material shall meet the requirements under relevant clause of this section.

19.18.5.5.3.1 **INTENDED USE**

19.18.5.5.3.1.1 **For areas important from radiological considerations**:

The epoxy coating would be used for painting the concrete floors, ceilings and walls. Mild steel surfaces on inorganic zinc silicate primed fabricated structural steel surfaces, construction joints caulked with polysulphide or epoxy mortar caulking compound, metallic expansion joints made from steel and copper etc. The materials used in the coating should not form radioactive isotope on absorbing neutrons. The paint should form a thick, radiation resistant, abrasion resistant, impact resistant, non-adsorbent, de-contaminable, humidity resistant, hot water and steam resistant liner.

19.18.5.5.3.1.2 For areas not important from radiological considerations:

The epoxy coating can be used for painting the concrete floors, ceilings and walls over Epoxy based compatible primer and on Mild steel surfaces over inorganic zinc silicate primed fabricated structural steel surfaces, construction joints caulked with polysulphide or epoxy mortar caulking compound, metallic expansion joints made from steel and copper etc. The paint should form a thick, abrasion resistant, impact resistant, non-adsorbent, humidity resistant liner.

19.18.5.5.3.2 **QUALIFICATION**

19.18.5.5.3.2.1 **For the areas important from radiological considerations:**

The qualification and procurement of epoxy paint shall be in accordance with PP-M-1219 as applicable. At the time of bulk supply samples shall be drawn from the batch in presence of representative from NPCIL, sealed and got tested by the contractor for batch tests in accordance with PP-M-1219 as applicable. The rate for application of paint shall include all the costs related with procurement.

19.18.5.5.3.2.2 **For the areas not important from radiological considerations:**

The Epoxy paint shall have following properties:

a) **For Epoxy on concrete floors**: The Epoxy shall be high build solvent free, self-smoothing, 4 component (Base, Hardener, Filler & Pigment) material. The DFT of coating (Excluding Primer) shall be minimum 1200 micron for its use on floors unless specified otherwise.

Property	Acceptance criteria	Reference Standard
Mixed Density	1.6+/- 0.05 kg/ liter	ASTM D14752
Pot Life	Min 40 min at 25 ^{0} C Min 15 min at 40 ^{0} C	ASTM C603
Setting time for foot traffic	15 Hour at 15 ^{0} C	ASTM D5895
Maximum Service Temperature	60 ^{0} C	ASTM 24712
Compressive Strength	24 MPa at 1 day 50 MPa at 7 days	ASTM C579
Flexural Strength	18 MPa at 7 days	BS 6319 PART 3
Tensile Strength	10 MPa at 7 days	BS 6319 PART 7
Abrassion Resistance H22 Wheel 1000 cycles – CS17 wheel	Less than 230 mg Less than 85 mg	ASTM D2240
Hardness, Shore D	Min 80	ASTM D2240
Adhesive Bond strength to concrete at 7 days	>1.5 MPa (Concrete failure)	ASTM D4541

b) **For Epoxy on concrete walls & structural steel**: The Epoxy shall be high build solvent free, 3 component (Base, Hardener & Pigment) material. The DFT of coating (Excluding Primer) shall be 250 micron for concrete walls & 200 micron on structural steel, unless specified otherwise.

Property	Acceptance criteria	Reference Standard
Mixed Density	1.48+/- 0.05 kg/ liter at 25 ^{0} C	ASTM D 14752
Volume Solids	100 %	ASTM D 2697
Pot Life	Min 60 min at 25 ^{0} C	ASTM C603-90
Setting time for foot traffic	2 days at 25 ^{0} C	ASTM D 5895
Compressive Strength	60 MPa at 7 days	ASTM C579
Flexural Strength	38 MPa at 7 days	ASTM C 580-02
Tensile Strength	8 MPa at 7 days	ASTM C307
Abrassion Resistance H22 Wheel 1000 cycles – CS17 wheel	Less than 230 mg Less than 130 mg	ASTM D2240
Hardness, Shore D	Min 80	ASTM D2240

Adhesive Bond strength to concrete at 7 days	More than 1.5 MPa Concrete failure	ASTM D4541

19.18.5.5.4 **SURFACE PREPARATION**:

Generally all surfaces to be painted shall be cleaned of oil, grease and other foreign matter. If the surface is very oily a detergent wash may be applied. The surface shall then be rubbed with No. 60 to 80 emery paper and the dust removed thoroughly with a clean cotton cloth.

19.18.5.5.4.1 CONCRETE SURFACES

Air water jet at a pressure of 7 Kg/cm2 shall be applied through a nozzle having a tip orifice of 1.5mm. The surface shall be allowed to dry. Pin holes if any exposed due to air water jetting shall be filled with cement paste and excess cement mortar shall be removed after drying by rubbing with emery paper followed by wiping with clean cloth.

In the case of floors, all laitance, stains and other deleterious substances shall be removed by using a floor polishing machine followed by a thorough air water jetting and cleaning. Oil and grease shall be removed by wiping with cloth soaked in thinner or acetone.

19.18.5.5.4.2 STEEL SURFACES

All steel work shall be cleaned of rust, scale, dirt, oil, weld splatter and other deleterious substances by shot blasting.

19.18.5.5.5 EQUIPMENT FOR PAINTING

Generally, only airless spray equipment of ratio not less than 66:1 shall be used for all painting works. Only trained personnel shall be allowed to operate the airless spraying equipment. The capacity of the equipment shall be such that it will provide maximum dry film thickness without sagging of the paint film. However, at places, where airless spray equipment cannot be used, painting with brushes shall be permitted at the discretion of the Engineer-in-charge only.

19.18.5.5.6 APPLICATION OF PAINT

General

Painting shall commence from top of walls and shall be worked down. Floors shall be painted from one corner working towards exit to avoid walking over painted areas. The paints shall be mixed and applied in accordance with manufacturer's instructions. Only approved primer coat shall be applied on the concrete or steel surfaces. The final finish

paint should give a dry film thickness as specified in drawings/ specifications. The thickness shall be made up in minimum number of coats as possible.

The curing time between successive coats shall be around 16 hours unless recommended otherwise by the paint manufacturer.

On concrete surfaces, inert filler shall be applied after the first coat to cover the uneven surface. It shall be noted that inert filler material shall not be applied over the entire surface as such layer will lead to loss of adhesion of the subsequent layers of paint. After application of the inert filler the surface shall be rubbed down with Nos. 80, 120 and 140 (as the case may be) sand paper and the rubbed surfaces cleaned by air jetting followed by cleaning with soft cloth before the successive coat of paint is applied. Each coat of paint except the final coat shall be slightly roughened using sand paper to obtain good adhesion of the successive coat of paint.

The paint shall be spread uniformly without runs, sags or brush marks (in case of brushing). Care shall be taken during spraying operations to hold the nozzle sufficiently close to the surface (not closer than 300mm) being painted to avoid evaporation of the volatile constituents of the paints and loss of materials into the air. The air pressure shall be kept at the required level through the entire painting operation. Each coat of paint shall be inspected after curing for the finish and dry film thickness. Necessary compositor plates shall be fixed on to the surface during painting, for checking the dry film thickness at various intervals as may be necessary. Wet film thickness gauges shall also be used during the painting and the thickness of wet film shall be recorded.

19.18.5.5.7 APPLICATION OF SELF LEVELING EPOXY FLOORING

The floor receiving the self-leveling epoxy flooring must be sound, dry, fine-grained and load bearing, free of laitance, loose and brittle particles and shall also be free from substrate and substances which impair adhesion such as oil, grease, rubber skid marks, paint or other contaminations.

The bond strength of the substrate must be at least 1.5 MPa. Ensure the compressive strength of the floor concrete is at least 25MPa and that floor slabs directly in contact with the ground have a proper vapour barrier installed and the moisture content of substrate shall not be higher than 4% throughout.

The temperature requirements shall be in the range given below:

A] Substrate temperature: 15°C - 35°C
B] Material temperature: 15°C - 30°C

The priming is essential to seal the concrete surface prior to the application of the self-level epoxy flooring. For primer shall be applied using medium nap roller ensuring a complete coverage without holidays, if after drying the surface appears patchy due to high absorption, recoating of primer shall be done in such areas. Primer shall be allowed to dry before commencing topcoat application of the self-level epoxy floor coating.

All mixing should be done mechanically, using a slow speed drilling machine fitted with a paddle, taking care to ensure that the mixing head is well within the material during mixing.
Applicator must wear spiked shoes during application. Mixed material shall be poured onto the primed and sealed surface and spread to full specified thickness using a pin screed or a notched trowel to achieve the specified thickness. The spread material should be immediately rolled with a spiked roller to release entrapped air and remove trowel marks. Control rolling shall be continued until all air is released well before the material starts stiffened.

19.18.5.5.8 PRECAUTIONS TO BE TAKEN

Required oil free compressed air at correct pressure shall be available with suitable compressors.

The equipment with all its accessories shall be cleaned immediately after the painting is completed with suitable thinner after painting.

All material such as paints, thinner, inert filler and Primer shall be stored safely, handled carefully and account of consumption recorded regularly. The paints used are volatile and hence proper ventilation shall be maintained in the areas of painting.

Explosion meters shall be used to constantly check the fume concentrations to avoid any explosion. The area to be painted shall be well ventilated by using fans/air blowers.

Sufficient lighting arrangements shall be ensured before start up of painting.

Proper staging and scaffolds shall be ensured while painting at heights.

Embedment, equipments pipes etc. shall be suitably masked before the painting commences.

After the painting, areas shall be cleaned of stains if any.
Care shall be taken to see that no welding/ Gas cutting is carried out where painting work is in hand or near to storage area.

19.18.5.5.9 Maintenance of records

A daily progress record shall be maintained.

19.18.5.5.10 Handling precautions

All the precautions must be taken to avoid direct contact of resin and hardener with skin. The persons handling epoxy resin and hardener must use rubber or polythene gloves. Parts of the skin, which come in contact with resin or hardener, should be washed with lukewarm water and mild soap. Manufacturer’s recommendation on these aspects should be followed.

19.18.5.6 ANTI CARBONATION, ANTI CORROSIVE AND WATERPROOF COATING

19.18.5.6.1 SCOPE

The specification described here covers material description, physical and mechanical properties, testing, applicable codes and standards, acceptance criteria, surface preparation and QA requirement etc. for protective coating using Aliphatic acrylate system on external surface of buildings unless specified otherwise.

19.18.5.6.2 MATERIAL

The protective coating on the external concrete surfaces shall be pure aliphatic acrylate system. It shall be single component; solvated aliphatic acrylic resin based coating for protection of concrete from carbonation, chloride ions, weathering and industrial pollution.

19.18.5.6.3 SURFACE PREPARATION

The surface shall be clean and free from loose particles, oil, grease, or any other contamination. The concrete surface shall be cleaned with wire brush and shall be washed with clean water. The surface having oil and grease shall be cleaned with detergents.

The surface irregularities such as blow holes, honeycombs, crevices and surface blemishes shall be filled with polymer modified cement putty mortar to achieve smooth and level surface this shall be allowed to cure by spraying water for two days and to dry for one day.

The substrate shall be in dry condition before the application of protective coating for better performance. The compatibility of this system shall be checked with the existing coating system, if any.

19.18.5.6.4 APPLICATION

Prepared Concrete substrate shall be applied with a compatible coat of primer at least 2 hours before application of Coating. The Primer shall have following properties.

PROPERTY	UNIT	TEST METHOD	ACCEPTANCE VALUE
Mixed Density	Kg/ltr	ASTM D 6237	0.95
Volume Solid	%	ASTM 5201	Min 32%
Over Coating Time	Hrs	ASTM D 1005	2 (at 25 ºC)

Over the primer the protective coating shall be applied using brush or roller or airless spray. The complete protective coating shall be applied in minimum one primer and two main coats. The first and the second main coat shall be applied approximately with a gap of 24 hours at right angles to each other. At low temperature, the subsequent coat shall be applied after ensuring that the earlier coat is fully dry.

19.18.5.6.5 **CURING**

The aliphatic acrylate based protective system is naturally air cured. Hence, no separate curing is required.

19.18.5.6.6 **COVERAGE**

The coverage depends on the type of surface (concrete, plaster, masonry) and surface finish. The Engineer In Charge shall check the coverage as per the manufacturer's specification. Engineer-in-charge shall verify the quantity of material used at site along with bills from the manufacture and the coverage specified in the manufacturer's specification.

The protective coating shall be applied in two coats over a primer coat. Each coat shall have a minimum thickness of 75 microns. The total dry film thickness inclusive of Primer shall be minimum 225 microns.

19.18.5.6.7 **STORAGE AND SHELF LIFE**

The material shall be stored under cover, out of direct sun light and shall be protected from extremes of temperature. The shelf life shall be as per the manufacturer's specification.

19.18.5.6.8 **Properties**

The properties of aliphatic acrylate based protective system are as follows. The base and system shall be pure aliphatic acrylate base and single component system.

PROPERTY	UNIT	TEST METHOD	ACCEPTANCE VALUE
Density	Kg/ litre		1.10 (min)
Volume solids	%	ASTM D 5201	37% (min)
Dry film thickness (DFT) for 1 Primer in white shade + 2 Top Coats	Microns	ASTM D 1186	225 microns in 1 Primer + 2 Top Coats
Adhesion with Concrete/ plaster surface	MPa	ASTM D4541	3.0 or concrete failure
Water vapour permeability test	gm/sq.m/day	ASTM D 1653	7 gm/sq.m/day at 75% RH at 25C (max)
Water penetration test	% weight gain	IS 3085	NIL at 5 kg/cm^2 hydrostatic test
Flexibility -Standard bend test		ASTM D 522	No cracks on the surface in 1/8 inch Mandrel

QUV- condensation test	Hours	ASTM G 53 for 500 hours	Passes - No discolourisation and chalking
A.C. Impedance Test in 3% sodium chloride	Coating resistance	Using Electrochemical impedence measurement for a frequency range of 100 KHz to 0.01Hz with AC amplitude of 20 Mv.	Initial value: $9x10^9$ Ohms (min) Final value after 30 days: $1x10^7$ 0hms (min)
CO2 diffusion resistance	Equivalent air layer thickness, R	AS/NZS 4548.5 – 1999: Taywood Method	>70m
	Equivalent Concrete Layer Thickness		>170 mm

Note: A.C. impedance test for the protective coating is required for application on RCC surface. This test may not be required for application on masonry/ PCC surfaces.

19.18.5.6.8.1 **Material**

Base: Aliphatic Acrylate Solvented System
Components: Single component

19.18.5.6.8.2 **Volume Solids**

Test Method: ASTM D 5201 –97 Standard practices for calculating formulation physical constants of paints and coatings.

19.18.5.6.8.3 **Dry Film Thickness**

Test Method: ASTM-D-1186: Test method for non-destructive measurement of dry film thickness of non magnetic coatings applied to ferrous base.

Methodology for adopting on concrete/masonry/plaster surface: Cleaned steel plates shall be fixed to the concrete surface firmly at regular intervals during application of protective coating. The dry film thickness (DFT) measurement shall be carried at every 100 sq.m area or part there off.

19.18.5.6.8.4 **Adhesion with concrete/ plastered surface**

Test Method: ASTM-D-4541-02: Standard test method for Pull-off strength of coating using portable adhesion testers.

19.18.5.6.8.5 **Water Vapour Permeability test**

Test Method: ASTM-D-1653: Standard test method for water vapour transmission of organic coating films.

19.18.5.6.8.6 **Water penetration Test**

Test Method: Water penetration resistance tested by immersing coated concrete cubes (5 cm x 5 cm x 5 cm size) for 12 days. Even at the end of 12 days, the weight gain shall be NIL to negligible.

19.18.5.6.8.7 **Flexibility- Standard bend test**

Test Method: ASTM-D-522: Standard test method for mandrel bend test for attached organic coatings.

19.18.5.6.8.8 **QUV- Condensation Test**

Test Method: ASTM-G-53: Standard practice for operating light and water exposure apparatus (fluorescent UV- condensation type) for exposure of non-metallic materials.

19.18.5.6.8.9 **Impedence Test (in 3.0% NaCl solution)**

Test method: Electrochemical impendence measurements for a frequency range of 100 kHz to 0.01 Hz with an AC amplitude of 20mV.

19.18.5.6.9 TESTING

The material shall be tested as per this specification by the contractor at no extra cost to NPCIL. Each batch of material used for the NPCIL job shall be tested in any of the approved independent laboratories. The independent test certificates along with the manufacturer's test certificate shall be submitted to NPCIL. The independent testing shall be witnessed by NPCIL representative, If felt necessary by the Engineer.

19.18.5.6.10 PACKAGING AND SHIPMENT

Materials delivered at site shall be clearly marked with legible and intact labels with manufacturer's name, brand name, product identification, manufacturing & expiry dates and batch number. The products shall be in original, unopened / sealed containers. Material shall be stored in areas where temperatures conform to manufacturer's recommendations and instructions.

19.18.5.6.11 SAFETY PRECAUTIONS

The work shall be carried out by an authorized contractors/applicator

The application shall comply with the procedure given above, all current relevant codes of practice and the Building Regulations.

All materials shall be stored clear of ground and moisture with weather protective covering. All the materials shall be kept away from sources of ignition.

The protective coating shall not be applied during inclement weather or when ambient condition is not allowing proper application.

Safety scaffolding, access ladders etc shall be provided in accordance with the current industrial safety and all the health and safety regulations shall be adhered to.

Care shall be taken during storage and use to avoid contact with eyes, mouth, skin and food stuff. The container shall be sealed after use.

19.18.6 PROTECTION

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationery equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instruction of the Engineer.

19.18.7 CLEANING UP

In addition to the provision in 'Conditions of Contract' 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.

19.18.8 ACCEPTANCE CRITERIA

a) All painted surfaces shall be uniform and pleasing appearance (gloss/ matt finish).
b) All varnished surfaces shall be of uniform texture and high glossy finish.
c) The colour, texture etc. shall match exactly with approved samples.
d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces

19.19 WATER SUPPLY, DRAINAGE AND SANITATION

19.19.1 SCOPE

The specification covers the general requirements for providing and laying water supply, piping, and providing and laying drainage lines.

19.19.2 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

The following IS Codes shall be applicable:

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

IS: 1200 - Methods of measurement of building and civil engineering works.

IS: 1239 - Steel Tubes, Tubulars and other wrought steel fittings. (Pt. I & II)

IS 16098-2-Structured-Wall Plastics Piping Systems for Non-Pressure Drainage and Sewerage –specification

IS 7634-2- Plastics Pipes Selection, Handling, Storage and Installation for Potable Water Supplies - Code of Practice, Part 2: Laying and jointing of polyethylene (PE) pipes.

IS 14333 -High density polyethylene pipe for sewerage

IS: 1742 - Code of Practice for building drainage.

IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS: 3076 - Specification for Low density polyethylene pipes for potable water supplies.

IS: 4984 - High density polyethylene pipes for potable water supplies.

IS: 458 - Pre cast concrete pipes (with and without reinforcement) - specification

IS: 783 - Code of Practice for laying of concrete pipes.

IS: 784 - Pre-stressed concrete pipes.

IS: 1726 - Specifications for Cast Iron Manhole Covers and Frames.
IS: 5961 - Specification for Cast Iron gratings for drainage purposes.

IS: 5219 - Specification for cast copper alloys traps. Part-1 - ‘P' & 'S' traps.

IS: 771 - Specifications for Glazed fire-clay sanitary appliances.

IS: 772 - Specifications for general requirements for enameled cast iron sanitary appliances.

IS: 774 - Flushing cistern for water closets & urinals (Other than plastic cisterns) - specifications.

IS: 775 - Cast Iron brackets & supports for wash basins and sinks.
IS: 2548 - Plastic seats and cover for water closets – specifications.

IS: 2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

19.19.3 DRAWINGS

a) Checked and approved drawings showing locations of sanitary and water supply fixtures will be furnished to the Contractor and all drawings so furnished shall form a part of this specification. The Contractor shall refer these drawings for all information contained thereon which pertains to and required for his work. He is, however, not to commence detail plumbing, water supply and drainage on the basis of drawings unless such drawings or parts of such drawings are officially released as 'Released for Construction'. Revision to drawing and any new drawings made to include additional work by the Contractor shall be considered a part of this specification and contract.

b) Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper and entire completion of the work and accordingly the job shall be carried out for completeness as required whether each item is mentioned here or not.

c) Based on line diagrams/drawings furnished by the Engineer, the Contractor will have to prepare detailed working drawings indicating the positions of fittings, valves, joints, nature, type and location of supports, connections to main lines etc. Four prints of each of these detailed drawings shall be submitted to the Engineer for approval. The drawings shall be got approved before proceeding with the execution of the work. The Contractor shall obtain permission from all local statutory authorities for all proposed works prior to commencement of execution and necessary fees, etc. shall be borne by him. The Contractor should, after completion of all works, give "as built" drawings incorporating all field changes made, for reference and use of the client. The final payment due to the Contractor will be effected only after such drawings are finalized.

d) Construction shall not be started until the Contractor has received copies of such drawings upon which the Engineer has endorsed approval. The approval of the Engineer of any of the drawings shall not relieve the Contractor from his responsibility for correctness of Engineering workmanship, fit of parts, details, materials, errors or commissions of any all work shown thereon. The Engineer's approval shall constitute approval of the design, sizes of pipes and layout only. The approval shall not invalidate any claim the Owner may make for damages on account of faulty construction.

e) The Engineer will return one copy of the Contractor's drawings marked with his approval/comments. The Contractor shall furnish the Engineer 2 prints and one reproducible of all final drawings for record purposes.

19.19.4 PIPING FOR PLANT DRAIN WORKS

a) Double walled corrugated pipes, conforming to IS:16098, Part 2

For equipment (plant) drain works underground double walled corrugated pipe conforming to IS: 16098, Part 2, stiffness class SN 8 shall be used. These pipes will be

used for external buried (underground) pipe lines. Work involved includes providing, jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints, laying and jointing conforming to IS : 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site, preparation of bed for laying the pipes etc. all complete as per manufacturer's specification.

b) HDPE pipes conforming to IS:4984

For equipment (plant) drains works underground HDPE pipes of higher diameter conforming to IS:4984, grade PE 100, pressure rating PN 6 shall be used. These pipes will be used for external exposed pipe lines. Work involved includes providing, laying or fixing in position including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints, laying and jointing conforming to IS: 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site, preparation of bed for laying the pipes etc. all complete as per manufacturer's specification.

19.19.5 PIPING FOR PLANT SEWER WORKS

a) Internal sewer works

For internal sewer works of main plant buildings under floors or against walls, HDPE pipes conforming to IS: 14333, grade PE 100, pressure rating PN 12.5 shall be used. Scope of work shall include providing HDPE pipes and fittings, laying or fixing in position including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints. Laying and jointing shall conform to IS: 7634 (Part-2).Scope shall also include cutting and trimming of pipes, preparation of bends as per requirement at site, taking suitable supports from Ceiling and walls/ preparation of bed etc. all complete as per drawings, manufacturer's specifications and direction of the Engineer.

b) External sewer works

i) For external sewers under gravity flow underground double walled corrugated pipe conforming to IS: 16098, Part 2:2013stiffness class SN 8 shall be used.Scope of work shall include providing pipes and fittings, laying or fixing in position, including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints. Scope shall also include laying and jointing of pipes conforming to IS: 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site, preparation of bed for laying the pipes etc. all complete as per manufacturer's specification.

ii) For external sewers under pressure, underground HDPE pipes conforming to IS: 14333, grade PE 80, pressure rating PN 6 shall be used. Scope of work shall include providing pipes and fittings, laying or fixing in position including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints. Scope shall also include laying and jointing conforming to IS : 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site,

preparation of bed for laying the pipes etc. all complete as per manufacturer's specification.

19.19.6 WATER SUPPLY PIPING AND FITTINGS

a) All water supply pipes shall be 'C' class (heavy duty) galvanized M.S. pipes of the specified internal diameters, conforming to IS: 1239**.** The pipes shall be fixed in longest possible lengths with all necessary bends, tees and couplings, reducing tees, etc. in perfect straight lines vertically and horizontally. For joining pipes threads of tube sand fittings shall be smeared with white lead and screwed down together with jute threads smeared with lead. Exposed surfaces of pipes shall be coated with 2 coats of oil paint if required by the Engineer. G.I. pipes shall be embedded in a chase out in internal wall chase shall be filled with cement mortar when directed at no extra cost. All G.I. pipes inside shaft shall remain clear off walls by at least half an inch. They shall be fixed with galvanized malleable iron bat clamps.

b) All brass or chromium plated fittings shall be of approved make and of the best quality, heavy cast or drawn brass, thoroughly annealed and shall be seamless.

19.19.6.1 **VALVES**

Valves shall be of best quality gun metal sluice valves unless specified otherwise, of screw down type with cast iron hand-wheel. Valves up to and including 15 mm diameter shall have threaded sockets.

19.19.6.2 **SUPPORTS**

a) Supply pipes, ladders, soil drain rain water and waste pipes etc. installed in a vertical position shall be hold firmly in place by GI/ W.I. clamps unless projecting ears with fixing holes are provided at socket and of pipes or by approved inserts wall fastened to the walls or structural framing.

b) Sleeves shall be provided for all pipes passing through walls floor and partitions, except at locations specifically forbidden by the Engineer. All sleeves shall be painted steel pipes. Pipe hangers where provided shall not be wider apart than 1.5 m on centres for cast iron pipes. General scheme for support arrangement shall be got approved by the Engineer before it is erected in position. The Engineer shall have the right to increase the number or strengthen or modify the supports at site.

c) All piping, where not concealed and where location is not specifically fixed by drawings shall run parallel and as close as possible, to wall.

19.19.6.3 **PLUMBING WORK**

The pipes before being laid shall be thoroughly cleaned specially the inside of pipes if required. Socket ends of pipes shall always face upstream of effluent flow. The drains shall run in perfect straight lines between manholes. The trenches shall not be filled in until the joints have been tested and alignment of drains and connections into and from

the manhole and their positions have been examined and certified and certified by the Engineer, if required. The whole of sanitary work comprising provisions of drainage and water supply arrangements including sanitary and water fittings and fixtures complete in all respects shall be carried out in accordance with the rules and regulations of the local authority through the agency of a licensed plumber. If required, the Contractor shall have to get all materials brought on site for incorporation in the work approved by the local authority at his own expense.

19.19.6.4 **PROTECTIVE PAINTING**

All exposed wrought iron clamps, steel suspenders or brackets for fixing the pipes to the wall face in case of vertical pipes and suspending the horizontal run of pipes shall be painted with one coat of zinc phosphate primer and two coats of paint of approved make and shade.

19.19.7 **TEST AND GUARANTEE FOR WATER SUPPLY, SOIL AND VENT SYSTEM**

a) Water supply lines shall be tested to a hydrostatic pressure of 12 times the design water pressure at any point over a period of 24 hours. All soils, waster, rain water pipes and vents shall be tested under a pressure of 3 meters of water. Rain water pipes shall be tested to a height of water equivalent to the height of the building plus 3 meters to ensure no leakage in case of choking sections by first installing test plugs in all openings, erecting 3 metres stand pipe, filling the system with water or by hydrostatic plus air test. Pipes shall be deemed to have passed the test, if water level in the stand pipe remains reasonably constant for a period of one hour.

b) The Contractor shall deliver to NPC upon completion of this work under this Contract a written guarantee: -

i) That for a period of one (1) year after acceptance by the Engineer, plumbing and drainage work shall be free from defective material and workmanship;

ii) That for a period of one (1) year after acceptance by the Engineer the Contractor shall be responsible for the tightness of all joints make by him;

iii) That he at his own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of guarantee;

iv) After the completion of the work, the Contractor shall obtain and hand over to NPC necessary certificates from the local authority/authorities concerned at no extra cost to NPC.

19.20 SANITARY FITTINGS/ FIXTURES AND TOILET REQUISITES

19.20.1 MATERIAL

All sanitary fixtures shall be of the best quality from approved manufacturers. Contractor has to obtain the approval from the Engineer, the names of the manufacturer whose product he proposes to use. All fixtures shall bear the seal of the approved manufacturer. All fittings, screws, gratings, etc. shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg per 25 mm diameter per metre length. After the fixtures are brought to the site, the Contractor shall arrange for their inspection by the Engineer and only after the approval, the fixtures shall be installed. All broken, damaged or rejected fixtures shall be removed from the site within two days after inspection.

19.20.2 INSTALLATION

All sanitary fixtures shall be installed to required level and plumb in the best workman like manner skilled labours and it shall be securely anchored to walls and floors.

All fixtures likely to be damaged shall be covered and protected during the progress of the building work, and uncovered after completion. Fixtures and accessories shall include all anchors and screw plates, screws, bolts, toggle bolts, expansion shields, set screws, wood blockings and plugs, lead connecting lead-pipes, etc. as required by the type of fixtures and accessories selected and by the type of construction to which they are connected. All fixtures and fittings shall be connected by water-tight joints. No dripping shall be accepted. All holes in walls and floors as required shall be made to the minimum desired size and depth only and they shall be properly made good and finished to match the existing finish. All brackets, supports, etc. shall be painted with a prime coat of anti-corrosive paint.

19.20.3 SANITARY FITTINGS &FIXTURES

The contractor has to mention the names of the manufacturers of the fixtures he intends to use. The sanitary fittings &fixtures shall be as described here under.

19.20.3.1 WATER CLOSETS

a) WESTERN STYLE

European water closet shall be of premium quality of size 710*390*765 mm of approved make and shade comprising of

(i) Double siphonic pattern coupled water closet with integral 'P' trap 180 mm roughing in and 'S' trap 250 mm roughing in,in glazed vitreous chinaware of matching colour.

(ii) 10 litres capacity PVC slim type single flushing low level flushing cistern (Dual Flush Tank white) with all fittings complete.

(iii) 15 mm NB heavy quality CP inlet connection pipe with brass unions and wiped solder joints at ends.

(iv) 15 mm NB screw down easy clean variety heavy quality CP brass angle valves with C.P. flange of superior quality.

(v) Germfree EWC solid seat cover (white) with C.P. brass hinges and rubber buffers of approved brand.

(vi) Jet spray provision with 1 Meter PVC tube (stainless steel) with 01 nos 15mm dia CP brass angle valve with CP flange as approved.

(vii) 15 mm NB heavy quality GI pipes and specials for overflow from cistern upto 150 mm above floor level, concealed in wall and terminated with 15 mm NB brass mosquito proof jali etc. all complete as per direction of the Engineer.

The European water closet shall be installed properly in all line and level as per direction of the Engineer.

b) INDIAN STYLE

Orissa type water closet shall be of premium quality of approved make and shade with 'P' or 'S' trap in vitreous chinaware best quality first grade with or without vent, having size 580mm x 440 mm or equivalent. It shall have following accessories.

(i) 10 liters capacity PVC slim type single flushing low level flushing cistern Dual Flush Tank with all fittings fitted over a pair of CI or MS bracket etc.

(ii) Lead valve loss syphon 15 mm nominal size, 32 mm NB GI flush pipe heavy quality of appropriate length with brass unions at end, wiped solder joints etc. complete.

(iii) 15 mm NB GI overflow pipe concealed in wall and brought down to 15 cm above floor level with mosquito proof jali at end as per specification.

(iv) 15 mm NB heavy type CP brass inlet connection with brass unions and wiped solder joints at ends.

(v) 15 mm NB heavy type CP brass screw down angle valve with C.P. brass flange of superior quality on inlet connection, recess concreting using 1:5:10 nominal mix as per site requirements.

The scope shall include all accessories, necessary brackets, supports, fittings, screws, gratings etc., installation including cutting and making good necessary opening chases etc. all complete as per specifications, drawing and as directed by the Engineer.

The WC pan shall be installed as per manufacturer's specifications. The W.C. pan shall be sunk in floor. The floor should slope towards the pan, care being taken not to damage the pan in the process of fixing. It shall be fixed on the proper cement concrete base taking care that the cushion is uniform and without having any hollows between the concrete base and the pan. The joint between the pan and the trap shall be made with cement mortar (1 cement: 1 sand) and shall be leak proof.

19.20.3.2 URINALS

(a) LIPPED URINAL

The lipped urinal shall be of premium quality white vitreous chinaware flat back lipped front urinal of approximate basin size 465 x 355 x 265 mm of approved make with PVC flushing cistern with all fittings, fitted on CI brackets, standard size galvanised iron flush pipe, waste pipe and CP brass spreaders with brass union, push cocks, specials, connecters & stopcock, CP brass fittings etc. and GI clamps, painting of fittings and brackets, cutting chase and making good the walls etc. all complete. The urinal shall be bowl type, flat back of angular, lipped front basin and shall be of glazed stoneware. It shall be fixed in position by using wooden plugs embedded in wall and screws of proper size.

The flushing of the urinals shall done for one urinal basin with 5 litres capacity automatic or equivalent with PVC flushing cistern. The flushing of the urinals shall done for range of two urinal basins with 10 litres capacity automatic or equivalent with PVC flushing cistern. It shall be supported on a pair of C.I. cantilever brackets which shall be embedded /fixed to wall by means of wooden plug and screws. The cistern shall be connected to urinal basin by means of C.F. brass flush pipe with fittings. The pipe shall be fixed by using proper holder – bat clamps.

The joint between the urinal basin and flush and waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

(b) URINAL PARTITIONS

The Urinal partitions shall comprise of be premium quality black granite of 18mm thick with rounded exposed corners etc. as approved by Engineer. It shall be in size 600 x 1000 mm or as approved by the Engineer. The scope shall include installation of partitions by cutting the wall & making good the same after fixing the partitions in approved pattern including all materials, labour, fittings and fixtures complete as per specification and direction of the Engineer.

19.20.3.3 WASH BASINS

(a) STANDARD WASH BASIN

The standard wash basin shall be premium quality glazed vitreous chinaware wash basin of approved make and colour having size 550 mm x 400 mm or equivalent. This shall include one pair of wall bracket of 35mm x 35mm x 5mm M.S. angle painted with two coats of white enamel paint of approved quality and make., 32 mm NB CP brass waste coupling heavy quality with rubber plug and chain, angle valve and PVC connector, 32 mm NB CP casted brass bottle trap with extension piece and wall flange and connected C.P. pipe as approved., 15 mm NB, CP brass pillar tap heavy deluxe type with triangular / roundish knob for hot & cold water and 15 mm NB CP inlet connection with all brass unions and wiped solders joints, One no. central hole C.P. brass basin mixer without popup waste system with 450mm long braided hoses of superior quality as approved., 32mm dia B class G.I. waste pipe (concealed) of required length (from bottle trap to nahani trap) including painting with anti-corrosive bituminous paint etc. and accessory required for installation and fixing of the wash basin all complete as per the direction of Engineer. The wall plaster on the rear shall be cut to overhang with top edge of the basin.

(b) OVAL SHAPED WASH BASINS

The oval shaped was basin shall be of premium quality glazed vitreous chinaware wash basin of approved make and colour having size 560 mm x 450 mm or equivalent. This shall include one pair of wall bracket of 35mm x 35mm x 5mm M.S. angle painted with two coats of white enamel paint of approved quality and make., 32 mm NB CP brass waste coupling heavy quality with C.P. grating, rubber plug and chain, angle valve and PVC connector, 32 mm NB CP casted brass bottle trap with extension piece and wall flange and connected C.P. pipe as approved., 15 mm NB, CP brass pillar tap heavy deluxe type with triangular / roundish knob for hot & cold water and 15 mm NB CP inlet connection with all brass unions and wiped solders joints, One no. central hole C.P. brass basin mixer without popup waste system with 450mm long braided hoses of superior quality as approved., 32mm diameter B class G.I. waste pipe (concealed) of required length (from bottle trap to nahani trap) including painting with anti-corrosive bituminous paint etc. and any other accessory required for installation and fixing all complete as per the direction of Engineer.

19.20.3.4 SINK

(a) VITREOUS CHINAWARE LABORATORY SINK

The vitreous chinaware laboratory sink shall be of premium quality glazed conforming to BIS 771 Part-2 of bowl size 600mm x 400mm x 200mm with integrated drain board of approved make including all fittings, CI brackets, CP brass chain with rubber plug, angle valve and connector etc. complete with 40 mm CP brass waste fitting and 40 mm CP brass trap with necessary CP brass union, CP brass connecting pipes and any other accessory as required etc. complete as per specification and direction of the Engineer. The scope includes installation of the sink as per manufacturer’s specification.

(b) STAINLESS STEEL SINK

The stainless steel sink shall be of premium quality of SS grade 304 glossy finish having size 600 x 400 x 200 mm (24"x18"x8") with edges rounded off. All fittings, fixtures, waste connection etc. shall be of standard size and appropriate for use with SS sink material. Accessories shall include: GI brackets: 32 mm NB CP brass waste coupling heavy quality with rubber plug and chain: 32 mm NB CP brass bottle trap with extension piece and wall flange: 15 mm NB CP brass inlet connection with all brass unions and wiped solders joints and all accessories such as choke stop stainer, outlet pipe upto floor trap and any other accessory as required. The sink shall be installed as required complete as per specifications and direction of engineer in charge.

19.20.3.5 **WATER CONNECTION**

Water connection to flushing cistern, wash basins and sinks shall be by means of PVC/ GI pipe connection pieces, with stop C. P. Brass cocks. The size of the PVC pipe connection and stop cock shall depend upon the size of water connection.

19.20.4 **TOILET REQUISITES**

a) MIRROR

Mirror shall be of premium quality cut edge mirror 6mm thick of overall size 600X450mm especially fabricated with superior glass (of approved quality) with designer acrylic PVC frame of approved colour and make mounted all-round with 6mm thick non-water absorbent Acrylic/PVC material backing fixed with cleats using C.P. brass screws and washers all complete as per the specifications and directions of Engineer. Scope shall include supply and fixing of mirror.

b) SHOWER SETS

Shower rose shall be of premium quality easy clean CP brass shower rose. It shall include shower arm 190mm long and wall flange of superior quality with 15 mm inlet of 100 mm diameter revolving type etc. all complete. Shower sets shall be swivel type CP brass shower rose, complete with water valve, supply pipes, and any other accessory etc. Scope shall include supply and fixing of shower rose.

c) GLASS SHELVES

Glass shelves shall be of premium quality of size 600 x 125 mm of sheet glass 6 mm thick or equivalent with CP brass brackets and guard rails, fixed to wooden cleat with CP brass screws. The scope shall include all fixtures and fittings required for installation of the glass shelves complete as per specifications and direction of the Engineer. Scope shall include supply and fixing of glass shelves.

d) TOWEL RAILS

Towel rods shall be of premium quality CP brass heavy quality of size 600 x 20mm with a pair of CP brass brackets, wall flanges etc. fixed to wall with CP brass screws, screwed on to rawl plugs. The scope shall include all fixtures and fittings required for installation of the glass shelves complete as per specifications and direction of the Engineer. Scope shall include supply and fixing of glass shelves.

e) LIQUID SOAP DISPENSERS

Liquid soap dispenser shall be of premium quality of CP brass with CP brass lid and brackets fixed to wooden cleat with CP brass screws. The scope shall include all fixtures and fittings required for installation of the glass shelves complete as per specifications and direction of the Engineer. Scope shall include supply and fixing of glass shelves.

f) TOILET ROLL HOLDER

Towel roll holder shall be of premium quality of size 150 mm x 150 mm or equivalent recess type in white glazed vitreous chinaware including cutting into wall and making good the same all complete. The scope shall include all fixtures and fittings required for installation of the glass shelves complete as per specifications and direction of the Engineer. Scope shall include supply and fixing of glass shelves.

g) COAT HOOKS

Coat hooks shall be of premium quality CP brass two pronged hooks fixed to wall / door with CP brass screws and rawl plugs including cutting and making good the wall etc. complete. The scope shall include all fixtures and fittings required for installation of the glass shelves complete as per specifications and direction of the Engineer. Scope shall include supply and fixing of glass shelves.

20 BUILDING JOINTS

20.1 EXPANSION JOINTS

20.1.1 SCOPE OF WORK

The work shall include providing and installing sealed expansion joints for various buildings in accordance with the requirements and details given in the specifications, drawings, schedule of quantities, together with the manufacturer's instructions, all to the complete satisfaction of the Engineer. The typical details of Expansion joint system are given in the enclosed drawing. The drawing given here is indicative. The contractor has to get the drawing prepared & approved before its actual use. The joints shall be designed utilizing extruded aluminum base members, self aligning / centering arrangement and support plates as applicable. The work involves sealing the Expansion Joints using properly designed extruded seals which may be mechanically fastened between extruded metal shapes, depending on the application. The design shall allow

for joint movement in all direction and shall guard against water ingress. The latter shall be provided for all external joints, joints in areas in contact with water and at all other locations as directed by the Engineer. The complete details of the material proposed to be used shall be furnished to the Engineer for his approval. The material shall be used only after obtaining the written approval of the Engineer. The contractor shall furnish the necessary documents, prepared by the manufacturer of the expansion joints, to enable the Engineer to satisfy himself regarding the suitability of the materials and adequacy of the design of the expansion joints.

20.1.2 The Work shall be carried out by the manufacturer or through an experienced manufacturer approved applicator, with the prior approval of the Engineer. In case, the work is carried out by the manufacturer-approved applicator, the manufacturer will have to provide the guarantee for the successful performance of total system including material & workmanship.

20.2 MATERIALS

20.2.1 The Expansion joint materials shall be procured from manufacturers such as Sanfield (India) Ltd. / Z. Tech (India) Pvt. Ltd/ BASF or any other equivalent as approved by the Engineer and shall be installed by the manufacturer themselves and not by any distributor / agent / any other externally appointed agency so as to guarantee the quality of workmanship.

20.2.2 The Material shall conform to the following Codes / Publications.

a) Aluminum Extrusions shall conform to ASTM B221. The alloy shall be 6063-T5 or Indian equivalent IS 63400.

b) Aluminum sheet and plates shall conform to properties of ASTM-B209. The alloy shall be 6063-T5 or Indian equivalent IS 63400.

c) Steel Shapes shall conform to ASTM-A36 or Indian equivalent IS: 2062.

d) Stainless Steel shall conform to ASTM-A-479 Gr. 304 or Indian equivalent IS: 6529 Gr. 0.4Cr18Ni10.

e) **Bronze Extrusions:** Materials shall be Architectural Bronze 385 Alloy.

f) **Electrometric Compression Seal**: these shall be preformed extruded multi-web cellular section of Chloroprene (Neoprene). Chloroprene shall conform to Clause 915.1 of IRC: 83 (Part II) and satisfy the Physical properties as Durometer Type “A” Shore hardness of 55±5and a tensile strength of 2000 PSI (min).

g) **Moisture barrier**: shall be vinyl EPDM / bituminous modified moisture barrier as recommended by the joint manufacturer or an approved equivalent, all as subject to the approval of the Engineer.

h) **Fire rated joint system**: shall have independent laboratory test reports reflecting the

endurance result of the materials run to time temperature curve.

i) **Elastomeric Joint Systems**: Material shall be a flexible extruded poly vinyl chloride or manufacturer's alternate material exhibiting a Shore "A" hardness of 64±5 with U.V. Stabilizer. Provide multi-cellular profile able to transfer loads to adjacent aluminum extrusions. The profile shall be flexible and exhibit a non-slip exposed surface that remains flat during all phases of movement. Block-out required for installation shall be provided at site by the contractor as per the dimensions given by the manufacturer.

j) Lubricant adhesive used shall be a one-part moisture curing polyurethane and aromatic hydrocarbon solvent mixture and shall conform to ASTM D4070.

k) **Visual seal**: shall be a flexible extruded poly vinyl chloride / santoprene or manufacturer's alternate material exhibiting Shore "A" hardness of 64±5 with U.V. Stabilizer. Other properties shall be in accordance with manufacturer's standard physical properties.

l) **Functional seal**: shall be flame retardant vinyl material.

m) **Sealant**: shall be a one-part polysulphide base synthetic rubber / Silicon sealant as per Manufacturer Specifications.

n) **Self-Centering Arrangement**: shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement so as to accommodate multidirectional seismic movement without causing stress to Joint components.

o) The materials used for Expansion Joints (other than air seal & metazeal type joint) shall have following properties.

Item Description	Given Specification	Indian Equivalent	Parameters to be Checked	Acceptable Values
Aluminium Extrusions. / Sheets & Plates	Alloy 6063-T5	IS 63400	Mechanical Properties Yield Stress (Ksi) Tensile Strength (Ksi) Elongation (%)	 15.00 21.00 8.00
Steel Shapes	ASTM – A36	IS: 2062	Mechanical Properties Yield Stress (Ksi) Tensile Strength (Ksi) Elongation (%)	 36.00 58.00 20.00
Stainless Steel	ASTM – A 479 Gr. 304	IS 6529 Gr. 0.4C Ni10	Mechanical Properties Yield Stress (Ksi) Tensile Strength (Ksi) Elongation (%)	 30.00 75.00 30.00

Neoprene Compression Seals	ASTM – D 2628	IRC – 83 (Part II) & MORT&H Specifications	Hardness (Shore "A") Elongation (%) [Min.] Tensile Strength (MPa) [Min.] Compression Set (%) [Max.]	55 +/- 5 250.00 13.80 28.00

20.3 JOINTS FOR NORMAL LOCATIONS

The Contractor shall provide all necessary accessories, related parts, devices, anchors etc. required for completing the installation of expansion joints in following locations.

a) Floor to Floor Joints at all internal locations
b) Roof to Roof Joints
c) Floor to Wall Joints at internal locations
d) Roof to Wall Joints
e) Wall to Wall Joints in exterior locations
f) Wall to Wall Joints & Slab to Slab Joints in case of underground trenches
g) Wall-to-Wall Joints & Slab to Slab Joints in case of underground tunnel subjected to ground water pressure from outside & water pressure from inside
h) Tunnel & Wall junction in case of underground structures.

20.4 JOINTS FOR CRITICAL LOCATIONS / HYDROSTATIC CONDITION APPLICATION

In case of underground structures which are susceptible for leakage due to ground water & hydraulic structures the expansion joint shall be provided with Airseal / Aladin type of expansion joint and/or Metazil type of expansion joint of M/S Sanfield / M/s BASF/ M/s Kanta Flex or any other equivalent with approval of Engineer. These joints are to be provided on the water face or both the faces depending on the wall thickness, severity of leakage & functional requirements as specified in the drawing or as directed by Engineer. These materials shall be qualified based on water hold test to the specified pressure and shall meet the following specifications.

20.4.1 AIR SEAL/ALADIN TYPE JOINT

The work shall consist supply and installation of Expansion Joint System model Airseal/Aladin of M/s Sanfield /M/s BASF or equivalent in accordance with the approved drawings and shall meet the following specifications.

The joints shall be designed utilizing neoprene profile, air pressurization and bonding in place with a specially formulated epoxy adhesive as per specifications.

The material shall be preformed, watertight, ozone and UV resistant, resilient and flexible neoprene profile with ribs on side faces for proper adhesion and bonding with the surface. The Joint shall be installed by air – pressurization technique only. Complete adhesion of the Epoxy to the neoprene seal profile and Joint Gap walls shall be achieved by air inflation during the installation. The relaxed (uncompressed) width of the seal

shall be equal to the Joint Gap value and the Seal shall be always installed in uncompressed position so as to allow maximum expansion & contraction movements. The Joint system should be able to sustain water pressures upto 2 Bars minimum.

The structural sealing joint profile shall be preformed and manufactured from an extruded neoprene compound exhibiting the physical properties listed in the table below.

TABLE 20.1
PHYSICAL PROPERTIES NEOPRENE COMPOUNDS

SL. NO.	*PHYSICAL PROPERTIES*	TEST METHOD	REQUIREMENT
1	Tensile Strength, Min.	ASTM D 412	2000 PSI
2	Elongation @ break, Min.	ASTM D 412	250 % Min.
3	Hardness, Type A Durometer	ASTM D 2240	65 + / - 5 Points
4	Oven Aging 70 hrs. @ 212 ^{o}F	ASTM D 573	
4.a	Tensile Strength	ASTM D 412	20 % loss Max.
4.b	Elongation	ASTM D 412	20 % loss Max.
4.c	Hardness	ASTM D 2240	0 to + 10 Points
5	Ozone Resistance @ 20 % Strain	ASTM D 1149	No Cracks

The adhesive used to fix the Airseal/ Aladin type joint with concrete/ steel surface shall be resistant to most common organic and inorganic acids in diluted form, also resistant to alkalis, water, oils, grease, etc. It shall have following properties.

SL. NO.	*PHYSICAL PROPERTIES*	TEST METHOD	REQUIREMENT
1	Tensile Strength, Min.	BS 6319	10 MPa @ 7days
2	Compressive Srength, Min. @ 25deg cen.	ASTM C 580	40 MPa at 1 day 60 MPa at 7 days
3	Flexural Strength	ASTM C 580	20 MPa at 7 days
4	Pot Life	ASTM C603-90	50 min at 25 deg cen. min at 40deg cen
5	Bond Strength, Min	ASTM D 4541	2 MPa.
6	Slant Bond Strength		13 MPa
7	Setting Time	ASTM D 5895	1 day Initial Cure 5 Days Final Cure

20.4.2 META ZEALTYPEJOINT

The work shall consist supply and installation of Expansion Joint System model Metazil of M/s Sanfield / M/s Z-tech or equivalent as approved by Engineer in accordance with the approved drawings and shall meet the following specifications.

The joints shall be designed utilizing a low density, closed cell, expanded polyethylene joint material and specially formulated epoxy adhesive for Bonding purpose as per specifications.

The material shall be a preformed, waterproof, ozone and UV resistant, resilient and flexible expansion Joint material. No Halocarbon gases or volatile hydrocarbons shall be used in the manufacturing of the product. The product should have a working

movement range of 60% compression and 30% tension. The Joint system should be able to sustain water pressures up to 2 Bars minimum. The same shall be demonstrated conducting water hold tests simulating site conditions. The product should be suitable for Potable water applications and should have ADA Compliance. The material shall exhibit the properties listed below.

PROPERTY	TEST	REQUIREMENTS
Density, Min.	ASTM D 3575	2.5 to 3.5 lb./cf
Tensile Strength, Min.	ASTM D 3575	70 psi
Water Absorption, Max.	ASTM D 3575	1.0 %
Compression Set, 22 hrs. @ 50 %	ASTM D 1056	
24 hrs. Recovery	(Residual Set, Max.)	8 %
Elongation @ break, Min.	ASTM D 3575	175 %
Tear Strength, Min.	ASTM D 624	13 psi

NOTE: For critical Joint locations, where the thickness of structural member (wall / slab) is exceeding 230 mm. Double layer Treatment comprising of Airseal on the critical / outer exposed face i. e. the face in contact with water / earth soil and Metazeal on the inner face is to be applied.

20.5 FABRICATION

20.5.1 Aluminum sections shall have factory-drilled holes spaced as per manufacturer's recommendation. Extrusions shall be miter cut at the site to suit directional changes.

20.5.2 Extrusions shall be supplied to site in their original packing in lengths as fabricated to suit the building dimensions.

20.5.3 Steel shapes shall be supplied in lengths as fabricated to suit the building dimensions.

20.5.4 Aluminum sections shall have mill finish unless otherwise specified.

20.5.5 Steel sections shall be blast cleaned and suitably treated against corrosion prior to their dispatch to the site. The cleaned metal surfaces which come in contact with the seal shall be protected against water logging / rusting till the seal and the adhesive are placed against the metal surface.

20.5.6 The Details of the finished colours offered by the manufacturer for Stainless Steel and Elastomeric components shall be furnished to the Engineer to enable him to exercise his choice.

20.6 EXECUTION

The expansion joint system shall be installed strictly as per the manufacturer's instructions and as directed by the Engineer. The work shall be carried out by the manufacturer or through an experienced manufacturer approved applicator, with the prior approval of the Engineer. In case, the work is carried out by the manufacturer-

approved applicator, the manufacturer will have to provide the guarantee for the successful performance of total system including material & workmanship.

20.7 QUALIFICATION OF MATERIALS

For qualification of material at site contractor shall supply the Test Certificates for the material confirming the properties given in above-mentioned tables. In addition to above one sample (3 specimens) from each batch supplied at site, shall also be tested at independent approved laboratory for all the desired properties listed above, in case of Neoprene compression seals & Airseal.

20.8 EXPANDED POLYSTYRENE BOARDS FOR EXPANSION AND ISOLATION JOINTS

20.8.1 GENERAL

Expansion and isolation joints in concrete structures shall be provided with expanded polystyrene boards of specified thickness and form expansion joints shall be provided with 500 micron thick polyethylene sheets as per the relevant drawings.

20.8.2 SCOPE

The scope of work covered under this specification is as follows:

- Supply and use of approved quality polystyrene boards wrapped in 250 micron thick polyethylene sheet at various expansion and isolation joints in all main plant buildings.
- Supply and use of 500 micron thick polyethylene sheets as form separation joint, wherever required.

20.8.3 MATERIAL

- High density polystyrene boards conforming to IS: 4671 of density 35 kg/m^3.
- Polyethylene sheets conforming ton IS: 5210 of 250 micron & 500 micron thickness.

20.8.4 DESCRIPTION

Heavy duty expanded polystyrene boards of specified thickness and sizes shall be wrapped all round with 250 micron thick polyethylene sheet. These boards shall be placed in the locations (both in vertical and horizontal) as specified in the relevant drawings. Polyethylene sheet shall be properly secured and tied in position with expanded polystyrene boards.

Wherever specified, 500 micron thick polyethylene sheet as form separation layer.

20.9 WATERSTOPS

20.9.1 GENERAL

Water stops made of polyvinyl chloride (PVC) or galvanised MS sheet shall be provided in construction joints as indicted in the relevant drawing and specifications for all main plant buildings including underground structures and tunnels.

20.9.2 SCOPE

The work under this specification comprises of

- Supply, delivery, install in position water stops in accordance with the requirements of specifications
- Polyvinyl chloride water stops
- PVC fix cap.
- Galvanised MS sheet water stop of 3.15 mm thick. Installation including necessary site connection by furing/welding.
- Testing of joints and DPT for 100% of the weld length.

20.9.3 MATERIALS

PVC water stops : Material shall conform to the following Standards of the American Society for Testing Materials (ASTM)

D412-66 Tentative method of Tension Testing of Vulcanized Rubber

D624-54 Standard method of Test for Tear Resistance of Vulcanized Rubber

D2240-64-TTentative method of Test for Indentation Hardness of Rubber by means of a Durometer

PVC fixocap type 38 or equivalent conforming to IS 4461

Metal water stops of 3.15 mm thick conforming to IS 2062 galvanised for dry film thickness of 60-100 microns.

20.9.4 DESCRIPTION

Generally water stops shall be provided in construction joints as indicated in the drawing, water stops may be PVC of different width (with or without centre bulb), fixco cap of standardtype GI water stopper of 3.15 mm thick plate made to different width. Generally, Fixo-cap shall be provided in expansion joints of underground tunnels and PVC water stops shall be provided in water retaining structures unless

specified otherwise by the Enginner .. The shear key shall be provided wherever specified and the water stops are generally located in the centre of wall at the construction joints or near to the edges in case of earth retaining walls and half of width shall be embedded into concrete. Necessary holding arrangement shall be made to ensure that water stops does not displace during concreting. It should be noted that, there shall not be any through supporting arrangement in order to prevent leakages. Continuity of the water stops shall be established by fusing or welding as the case may be. PVC water stops shall be joined together by fusing and metal water stops shall be 75 mm overlapped and welded on both sides. 100% dye penetrant test shall be carried on all joints. As far as possible care shall be taken to minimise the number of joints and also in-situ fusing/ welding.

21 Aluminium Lineal False Ceiling

Aluminium lineal suspended ceiling work shall be executed in flat, tapered, curved or circular form, both in plan and in section together with coves, etc. as required as per design.

21.1 General

Aluminium lineal ceiling shall be of Hunter Douglas as manufactured by Luxalon Building Products or approved equivalent together with all accessories and fittings such as carrier and clip, carrier splice, edge cover profile and corner splices, cross "T" connection near to the wall, etc.

21.2 Materials

21.2.1 Panels

The panels shall be 84C or 84R as per Luxalon's catalogue or approved equivalent and either plain or micro perforated. The length of the panel shall be 6m approximately. The panels shall be of any colours as approved by the Engineer, according to manufacturer's colour chart.

21.2.2 Panel carriers

Panel carriers shall be 4mm dia enamelled aluminium of satin black colour as per Luxalon's catalogue. The edges shall be provided with edge cover profile with a gap of specified width from the wall.

21.2.3 Suspension

The panel shall be suspended from the suspension system as mentioned in the relevant clause by means of adjustable turn buckle / level adjuster etc. In addition to the suspension system, the panel carriers shall be suspended by means of adjustable suspension steel rods of 4mm diameter with threaded rods and nuts for micro levelling, fixed to the slab/ beam by expansion fasteners. The expansion fasteners shall be fixed with epoxy/polyester resin. Seismic anchoring and isolation shall be provided as

directed by the Engineer. Bracing shall be provided as specified for Gypboard ceilings.

21.2.4 Acoustic Pads

Acoustic pads shall be laid on top of perforated panels. Acoustic pads shall be of the approved manufacturer and shall consist of an insulation of 25mm thick glass wool pad having a density of 32 kg/cum wrapped in glass cloth. The provision of these acoustic pads for perforated ceiling is deemed to be part of the quoted rate and noting extra shall be payable for the same.

21.3 **SHOP DRAWINGS**

Shop drawings shall be prepared for all suspended ceiling work by the Contractor. The shop drawings shall show the entire installation system, including framing around light fixtures, ducts, grilles, access panels, etc. Shop drawings shall be submitted to the Engineer for approval. It will be the responsibility of the Contractor to co-ordinate with all the service Contractor's doing work in ceilings, to incorporate appropriate suspension systems free of ducts, pipes, cable trays etc.

21.4 **APPROVALS**

The Contractor shall submit catalogues, samples of all items to be used in the ceiling and samples of workmanship, for approval of the Engineer.

22 GLASS AND GLAZING

22.1 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.

In general, wherever applicable and unless otherwise noted, the work shall conform to IS 1081. Fixing and Glazing of metal (Steel and Aluminium) Doors, Windows, and Ventilators.

22.2 Installation

22.2.1 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, unless otherwise stated in the drawing or schedule. All glass shall be of superior quality from approved manufacturer like Modiguard or equivalent, having uniform refractive index and free from flaws, streaks, laminations and bubbles. The glass should be free from "wavy and rainbow formation". Float glass for glazing and framing purposes shall conform to IS : 1761 . The glass shall be brought to site in the original packing from the manufacturer and cut to size at site. The cut edges shall be straight and free from chips, spalls or any other damages. Wherever clear glass is

specified, it shall be flat drawn float glass and shall be at least 6mm thick. Where wire glass is mentioned, it shall be thick rolled glass with centrally embedded wire mesh of Georgian type. Where obscure glass is mentioned, it shall have a cast surface on one side. Heat absorbent and glare reducing glass shall be 'Calorex' of Modiguard , having a thickness of 6 mm unless specified otherwise in the schedule of Quantity. The Contractor shall submit samples of glasses for prior approval of the Engineer.

22.3 **Putty**

In general, the putty shall conform to IS:419. The putty shall be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty shall be used for windows and sashes except when glare reducing glass is used.

Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer’s instruction and shall sit snugly against glass to give a leak proof installation.

22.4 Glazing, Setting and finishing

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 IS Codes, four glazing clips shall be provided per glass pane, except for large panes where six or more clips shall be used as per the Engineer's instructions. All holes that may be necessary for holding the clips and for all other attachments, shall be drilled by the Contractor at his own cost.

Glass panels shall be set without springing, and shall be bedded in putty and back puttied, except where moldings are specified. Putty, mastic cement, etc. shall be smoothly finished to a true even line. Obscure 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 NPCIL during handling, transportation, fixing etc. and shall replace the same at his own cost.

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 Contractor's own cost.

22.5 **Float glass for Doors**

Float glass for vision panels in door shall have a minimum thickness of 4.0 mm unless otherwise specified or shown on drawings.

22.6 **Acceptance Criteria**

a) All installation shall be free from cracked, broken or damaged glass. Edge of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipping cracked or ungrounded edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

22.7 **Drawings**

The contractor has to submit the drawings based on the above specification while quoting for these items.

23 ROOFING INSULATION, WATER PROOFING ETC.

23.1 SCOPE

The work under this specification shall cover all insulation and waterproofing necessary for the roofing work as shown in the drawings.

23.2 INSPECTION OF SURFACES

Prior to start of the work, the surfaces on which waterproofing /insulation is to be applied shall be inspected by the contractor and any visible/ noticeable defects found in the surfaces shall be rectified. The water ponding test shall be conducted by ponding water on the roof slab and maintaining minimum 50 mm head of water on it for a period of 3 days. Any noticeable leakage/ seepage shall be corrected by the contractor at no extra cost to NPCIL. The surface then shall be made clean and dry before laying screed concrete/ starting roof insulation / waterproofing work.

23.3 SCREED CONCRETE

The grading shall be provided by an under bed using M-15 grade concrete (with max 10 mm aggregate) prepared properly to the satisfaction of the Engineer Unless otherwise specified, the grading shall be done in such a way so as to ensure a run-off gradient of not less than 1 in 120. The minimum thickness at low points and/or valleys shall not fall below 25 mm. After curing the under bed for 7 days, insulation work shall be taken up with prior approval of the Engineer. The screed concrete shall be laid on the invert of gutters for maintaining slope in the gutter.

Fillets at junction of roofs and vertical walls/ pedestals etc. shall be provided along with the roof screed concrete. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

23.4 INSULATION

23.4.1 MATERIAL

In case of structure where thermal insulation requirements are specified in the drawings or as decided by the Engineer, the concrete surface shall be applied with polyurethane foam (PUF) insulation. The PUF should be a 75 mm thick layer of two components high density spray applied polyurethane resin foam. The spray PU foam is carried out by a smooth spraying or pouring (for small areas) action to obtain the fill. The spray application to be done using specially designed spraying machine. The product must comply to class B2 as per DIN 4102, part 1 and shall exhibit the following properties:

PROPERTY	**ACCEPTANCE VALUE**	**TEST METHOD**
Core Density	40 Kg/m^3	DIN EN ISO 845,
Thermal conductivity (λ),	< 0.024W/(m.K)	DIN 52612
R-Value of 50mm thick,	> 2.1	ECBC Code
Compressive Strength,	DIN 53423,	>175KPa
Flexural Strength,	DIN 53423,	> 250KPa
Closed Cells	ISO 4590	90%
Water Vapour Diffusion	DIN 52615	60
Water absorption,	DIN 52848	<2.25%

23.5 WATER PROOFING

23.5.1 FOR BUILDING ROOFS

After completion of the curing period of the roof slab/ screed concrete and insulation (wherever applicable), the top surface shall be waterproofed using a solvent free spray applied polyurethane membrane.

In case of concrete prior to application of PU membrane, the surface should be ensured to be sound, clean and free from grease, oil or loose particles, laitance free shall have at least 1.5N/mm2 surface strength and moisture content shall be less than 4%. The concrete can be considered sufficiently dry when the relative humidity at the surface falls to 75% or less when measured with a hygrometer conforming to BS 8201 Appendix A. The preferred surface pretreatment for concrete is grinding or scarifying as necessary for concrete or when the primer has become soiled or when the re-coating interval has been exceeded.

The scope of work shall cover supply and application of one coat of primer (DFT 75 micron) and polyurethane membrane of approved make for total dry film thickness of 2200 microns comprising 2000 Microns thick (DFT) base coat of aromatic/ aliphatic PU and 200 Microns thick (DFT) UV resistant Aliphatic PU top coat excluding primer on flat or curved roofs.

a) Priming shall be done when the temperature of the substrate is at least 3 degrees above the dew point with a two pack epoxy primer with outstanding resistance properties and shall contain a high level of penetrating pigment which renders superior performance when sprayed over concrete having the following properties:

PROPERTY	**TEST METHOD**	**UNITS**	**ACCEPTANCE VALUE**
Density	ASTM 4052	g/cc	1.09 + 0.05 at 25°C
Mixing Ratio, by weight	IS 104		As per manufacturer recommendations
Flexural Strength	ASTM C 580-02	MPa	>30 at 7 days
Tensile Strength	BS6319 Pt 7	MPa	>20 at 7 days
Compressive Strength	ASTM C 579	MPa	>65 at 1 Day >70 at 3 Days >75 at 7 Days
Adhesive Bond Strength	ASTM D 4541	MPa	>1.5 at 25°C

For acceptance of material listed in above table, Manufacturer Test Certificate (MTC) from manufacturer confirming to above specified properties except for Tensile, Compressive &Bond strength shall be acceptable. The Tensile, Compressive & Bond strength tests shall be conducted by the contractor as per QAP in laboratories like IITs, ICT etc. or other Government approved/ NABL accredited laboratories as acceptable to NPCIL at no extra cost to NPCIL.

On the tacky primer surface, sand shall be broadcasted using dried, graded silica sand (size 0.3 to 0.9 mm) on to applied Primer Coat prior to its hardening. The sand shall be evenly spread over the entire primed surface at the rate of 0.8 to 1.0 Kg/m2. When the surface is sufficiently cured, the surface is vacuumed to remove any loose sand.

The waterproofing system base coat shall be solvent free, two-component, fast setting, seamless spray applied Aromatic / Aliphatic Polyurethane (PU) membrane installed over the roof on primed substrate (concrete screed) using a pneumatic machine as per the manufacturer's specifications. The machine for application shall have optional pressure monitor kit to assure on mixing ratio. The pressure gauge shall monitor the spray pressures on both sides and shall automatically shut down the sprayer in case of non-acceptable conditions, like running out of material, pump cavitation, packing failures, leaks in valves or fittings, or plugged filters. The two component spray applied PU membrane for base coat shall have a total average dry film thickness of 2000 microns (excluding primer and top coat, with no single value less than 1800 microns). It shall possess the following properties:

Sr No	Property	Test Method	Values
1	Solids Content	ASTM D2697	> 95%
2	Density	ASTM D1475	>1.0 g/cm3
3	Ready for Light Traffic	DIN 53213	Max. 60 seconds
4	Adhesion Strength	ASTM D4541	Minimum 3.5 N/mm^2
5	Tensile Strength	ASTM D 412	> 8 MPa
6	Impact Strength	ASTM G14	>190 N/sq mm
7	Elongation at break	ASTM D 412	>400%
8	Average Tear Propagation	DIN 53363	>35 N/mm
9	Tear strength	ASTM D624	>25 N/mm
10	Puncture Resistance	ASTM E 154	>300 N
11	Crack bridging	ASTM C 836	No crack till 5 mm crack width
12	Shore Hardness (Shore A)	ASTM D2240	>65
13	Taber Abrasion Resistance	ASTM D4060	< 70 mg
14	Water Vapor Transmission	ASTM E 96	0.11 g/m2/day
15	Root Resistance	DIN 4062	No penetration

For acceptance of material listed in above table, solid content, density, tensile strength, % elongation at break, crack bridging & shore A hardness shall be performed in laboratories like IITs, ICT etc. or other Government approved/ NABL accredited laboratories as acceptable to NPCIL for every individual batch. For all other tests, MTC from manufacturer conforming to above specified properties shall be acceptable. Pull off adhesion test shall be done at site as per relevant standards using a portable pull off adhesion tester. All the laboratory tests shall be conducted by the contractor as per QAP at no extra cost to NPCIL.

b) The solvent free, two-component, spray applied base Polyurethane membrane system shall be protected using a two-component polyurethane UV stable aliphatic top coat having average 200 microns thick DFT (with no single value lesser than 150 microns). The top coat material shall have following properties:

Sl No.	Property	Test Method	Values
1.	Elongation at break (14 days)	ASTM D 412	>150%
2.	Tensile Strength (14 days)	ASTM D 412	>10 Mpa
3.	Tear strength	DIN 53515	>60 N/mm
4.	Density (Mixed)	At 20ºC	1.2 g/cm^3
5.	Viscosity (Mixed)	ASTM D2393	2000-4000 CPS at 23 degree C
6	Accelerated UV resistance	ASTM G 154	>1000 hours i.e No cracking, blistering or flaking
7	Shore A Hardness	ASTM D 2240	89

For acceptance of material listed in above table density, tensile strength, % elongation at break & shore “A” hardness as applicable shall be performed in laboratories like IITs, ICT etc. or other Government approved/ NABL accredited laboratories as acceptable to NPCIL for every individual batch. For all other tests, MTC from

manufacturer confirming to above specified properties shall be acceptable. All the laboratory test shall be conducted by the contractor as per QAP at no extra cost to NPCIL.

23.6 PROTECTION SCREED CONCRETE

The water proofing done on roof other than OC dome shall be protected against damage due to working of other agencies on the roof top, wherever specified or decided by the Engineer. The membrane shall be overlaid with a layer of M-15 grade concrete (with max 10 mm aggregate) for a thickness of 50mm. The concrete shall be laid in panels of 2m x 2m, with an expansion groove 10 mm wide and 15 mm deep between the panels. The expansion groove shall be sealed with polyurethane sealant.

23.7 TESTING OF THE ROOF WATER PROOFING

The water proofing system on roof other than OC dome shall be tested by ponding water for a depth of 50 mm over the membrane layer, before laying the protective screed concrete. The water shall be retained for a period of 24 hrs and inspected for leakages if any. In case leakage/ seepage of water is observed, the contractor shall identify the leakage/ seepage spots and take corrective action as per manufacturer's recommendations at no extra cost to NPCIL. Repair procedure shall have the approval of the Engineer. The cost of testing the water proofing system is deemed to be included in the item rate for water proofing.

23.8 PROJECTING PIPES AND PEDESTALS ON ROOF TOP

The pedestals on the roof top and pipes passing through a roof on which water proofing treatment is to be laid, a cement concrete angle fillet shall be built around it. The spray PU water proofing treatment shall be taken over the fillet in the manner shown in drawings. Where pipe is passing through pipe sleeve embedded in concrete, a 20 mm Square groove shall be cut at top of concrete around pipe sleeve and the same shall be filled with a hydro-swelling polymeric paste of 1.5kg/litre mix density. The paste shall be formulated to exhibit low premature swelling (less than 50% within 12 hours) and shall not release super absorbents during its service life. The re-swelling paste shall have low swelling pressure; not exceeding 0.25 MPa at full swelling capacity; confined between mortar & cement concrete angle fillet.

23.9 QUALITY ASSURANCE & SUPERVISION

A detailed work procedure in line with this specification and manufacturer's specification with resources deployment shall be prepared by the contractor and submitted to NPCIL for approval before proceeding with the work. Contractor shall carry out testing of materials as per direction of Engineer and shall submit testing reports and manufacturer's test certificates to the Engineer. A strict check on coating thickness and consumption of coating material shall be exercised by Contractor's QA Engineer and necessary records in this regard shall be submitted to NPCIL. Contractor shall provide necessary assistance to NPCIL in supervision of roof insulation and water proofing work and checking of PU coating thickness.

During the entire process of work under this specification, the Contractor shall arrange at his own cost the supervision of the work on insulation, water proofing and flashing by the manufacturer's representative to ensure that the work is being executed as per manufacturer's specifications and instructions.

23.10 GUARANTEE

The Contractor shall be responsible for maintaining the roof top insulation for a period of 10 years from the date of acceptance of the water proofing work by the Engineer. The Contractor shall make periodical inspection especially before start of the rainy season and repair the waterproofing for any apparent defects to ensure effectiveness of water proofing during the guarantee period.

The Contractor shall submit a bank guarantee from a scheduled commercial bank (other than co-operative bank) for 10% of the cost of roof insulation and water proofing works carried out. The bank Guarantee shall be valid for a period of five years from the date of acceptance of the water proofing work by NPCIL.

24 SURFACE DRAINS, UNDERGROUND TUNNELS, TRENCHES, SEWAGE CONVEYING SYSTEM ETC.

24.1 SCOPE

This specification covers furnishing all materials, plant, labour, equipment tools and services for the complete and proper construction of storm water, surface drainage, pitching using fly ash bricks and culverts as specified herein and shown in the drawings including all surveying and setting out necessary for the same and clean up of working areas.

24.2 GENERAL

All drains and culverts shall be constructed at the locations shown in the drawings or as directed by the Engineer. Care shall be taken to avoid clogging of the drains during progress of the work and should any drain become clogged or obstructed from any cause until final acceptance of the work, it shall be cleaned in a manner as approved by the Engineer or replaced by the contractor at no extra cost to NPCIL.

24.3 EXCAVATION

Excavation for storm water/ surface/ cut off drain and for culverts/ for laying RCC hume pipes shall be carried out as per the requirements covered in the technical specification for 'Excavation, Dewatering and Backfilling'

The excavated material shall be removed from the excavated/ adjoining area and disposed of at location(s) as directed by the Engineer.

24.4 STORM WATER/ SURFACE DRAINAGE

Where shown in the drawings, storm water/ surface drainage shall be constructed consisting of RCC trenches. Storm water/ surface drains shall be placed to prevent ground water from flowing directly into the structures and shall be constructed to a line and grade to allow proper drainage over the area of the site to the nearest natural drainage and in turn to the nearest natural water body. The contractor shall construct the storm water/ surface drainage system as per the details shown in the drawings.

24.5 PITCHING

Fly ash bricks of nominal size of 230x110x70 mm having compressive strength of minimum 75 Kg/sq cm shall be used in the work. Bricks shall be laid over sloped/ flat surfaces of the drain over well prepared and compacted bed of insitu soil. The joints between the bricks shall be filled with 1:6 cement mortar. Provision of weep holes with filter media etc. shall be provided in the pitching.

24.6 CUT OFF DRAINAGE

Where shown in the drawings, deep cut off drains shall be constructed at the various elevations to a line and grade to allow lowering of ground water levels and to arrest seepage water and surface runoff and direct the same to the nearest natural drainage for further flow to the nearby water body. The cut off drains shall consist of deep trenches, with concrete lining finished smooth of the bottom and the side facing as given in the drawing.

24.7 CULVERTS

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per drawings and as directed by the Engineer after clearing the site etc. as per specifications of Earthwork. The construction of culverts shall be done true to line and levels as shown in drawings. The specification for masonry and/or plain and reinforced concrete shall be followed as applicable**.**

24.8 REINFORCED CONCRETE SPUN PIPES

24.8.1 GENERAL

The drainage pipes unless otherwise shown in the drawings or instructed by the Engineer shall be made of R.C.C. and shall be of class NP3.

Pipe culverts shall also be made of reinforced concrete pipe and shall be of class NP3. All pipes materials shall meet the requirements of IS: 458-Latest edition and shall be procured from approved manufacturers with collars as per manufacturers standard specifications.

24.8.2 APPLICABLE CODES

The manufacture, testing, supplying, jointing and testing of pipes at worksite shall comply with the code of practices, latest revisions, as given below:

IS: 456 Code of practice for plain and reinforced concrete

IS: 458 Specification for concrete pipes (with and without reinforcement)

IS: 783 Code of practice for laying of concrete pipes

IS: 3597 Method of tests for concrete pipes

24.8.3 CARTING AND HANDLING OF PIPES

Pipes and fittings shall be transported from factory to work sites by the Contractor and he shall be responsible for the safety of the pipes in transit and loading/unloading. Any pipe, which shows sufficient damage to preclude it from being used, shall be discarded. Dragging of pipes along concrete or similar pavements shall not be allowed.

24.8.4 STORAGE OF PIPES

Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom to keep the stack stable. The stack shall be in pyramid shape with height of pyramid not exceeding 1500 mm.

24.8.5 LAYING OF PIPES

a) Laying of concrete pipes shall correspond to IS: 783 – Latest edition – and specification given below. Safety requirements to be provided while laying of pipes shall conform to IS: 3764.

b) The foundation bed for pipe shall be excavated true to lines and grades shown in 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 not more than one-third the diameter of pipe unless otherwise instructed / permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the contractor without any extra cost. Side slope, if there be any, shall be removed by the contractor without any extra cost. Pipes shall be carefully lowered with the help of tripods with chain pulley blocks or any other mechanical means in the approved trenches. In no case pipe shall be dropped. Pipes damaged during lowering shall be rejected by the Engineer. After laying of the pipes are completed, back-filling 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-lying areas within the plant area, as instructed by the Engineer.

c) 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 of fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

d) Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

e) 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.

f) Laying of pipes shall start from the outlet and proceed towards inlet. Pipes are to be laid perfectly true both in alignment and to gradient specified. Pipes must be secured in place with approved backfill material tamped under it except at the collar. Precaution shall be taken to ensure that dirt do not enter jointing space. Pipes shall be laid such that the marking on pipes appears at the top of the pipes.

g) 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 shall be 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 the earth filling material shall be 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.

h) If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS: 783.

i) When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than N/20. 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.

j) The drop walls shall be made with first class brickwork or stone masonry in 1:4 cement mortar.

k) 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 instructed by the Engineer.

24.8.6 Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes shall be suitably supported avoiding reinforcements of concrete blocks, and joints properly done before concreting is taken up. Concreting of total height of the block may be done in one single operation or may be done up to some height for pipes to be properly laid in position and the remaining height of the block concreted subsequently.

24.8.7 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.

24.9 ROOF DRAIN PIPING

24.9.1 Double walled corrugated pipe (For underground works)

Underground double walled corrugated pipe conforming to IS: 16098, Part 2, stiffness class SN 8 shall be provided for roof drains works. The scope of work includes supplying pipes including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints, laying and jointing conforming to IS: 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site, preparation of bed for laying the pipes and any other fitting, fixtures, accessories required to complete the job etc. all complete as per manufacturer's specification and direction of the Engineer.

24.9.2 HDPE pipes for Roof drains works (Above ground)

HDPE pipes conforming to IS: 4984, grade PE 100, pressure rating PN 6 shall be used for elevated roof drain works. Scope of work includes supply of pipes including jointing of pipe to pipe or pipe to long neck pipe ends by electric heating mirror at site, joints to be flanged joints, laying and jointing conforming to IS: 7634 (Part-2), cutting and trimming of pipes, preparation of bends as per requirement at site, preparation of bed for laying the pipes etc. and any other fitting, fixtures, accessories required to complete the job etc. all complete as per manufacturer's specification.

24.9.3 RAIN WATER DOWN COMERS

24.9.3.1 GENERAL

Rain water down comers shall be ultra violet stabilized UPVC rain water pipes conforming to IS: 13592 Type-A and shall run along the exterior wall / column surface of all main plant buildings, unless specified otherwise.

24.9.3.2 SCOPE

The scope of work comprised in this specification are as follows:

- Supply, erection, fixing UPVC pipes at various elevations of main plant buildings including UPVC/ heavy cast iron roof drain and floor drain, all fittings and fixtures and including leak testing of the erected system.

- Supply, fixing necessary fittings inclusive of shoes, gratings, bends, sockets etc.

24.9.3.3 MATERIALS

- Ultra violet stabilized UPVC rain water pipes conforming to IS: 13592 Type-A and fittings conforming to IS 5382/ IS14735.

24.9.3.4 DESCRIPTION

Rain water down comers shall run along the exterior surface of walls/ columns and longitudinally over the roof and to be secured well to walls/ columns with strong clamps/ brackets as specified in the relevant drawings. Where desired by the Engineer these may have to be installed in chases cut in the structure. The brackets may be of galvanized iron/ anti-corrosive material clevis type, split ring 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 shall be provided against the vertical surface. All bends and junctions shall be supplied with water-tight clean outs.

Roof drains at top shall be provided at locations as specified in the drawing and shall be provided with suitable MS gratings where ever specified.

25 QUALITY CONTROL, SURVEILLANCE AND ASSURANCE REQUIREMENTS

25.0 SCOPE

This chapter specifies requirements to be incorporated in the Contractor's quality assurance program for construction. The Contractor is responsible for planning and developing a program that assures that all his management, design and technical responsibilities for quality are incorporated and executed effectively. The program is aimed primarily at ensuring an efficient quality management in construction and taking corrective actions, when necessary.

Planning and detailed written procedures are essential for specifying how such activities as the following, which affect quality, are to be performed and controlled.

a) Design management whenever applicable

b) Procurement

c) Construction

d) Special processes

e) Measuring and testing equipment

f) Inspection and test

g) Handling, storing, preservation, packaging and shipping.

h) Item identification and traceability

i) Documentation and quality records.

j) Disposition of non conformances and corrective action.

25.1 APPLICABILITY

The requirements of this chapter apply to the construction activities when specified in a contract.

25.2 CONTRACTORS RESPONSIBILITIES

The Contractor's responsibilities

a) To develop and implement the controls and quality assurance procedures, specified herein, that will promptly detect and dispose of, or prevent, non-conformances to contractual requirements.

b) To comply with the NPCIL's requirements as specified in the contract.

c) To prepare a quality assurance manual which shall be submitted for the Purchaser's concurrence before the contract is awarded or at the latest before the work starts. This manual should cover activities of building design consultant, proof check consultant and building contractor and their subcontractors.

d) To prepare a quality plan which shall be submitted to the Purchaser before the work starts, as required in 25.3.3 (b).

e) To update and resubmit the quality assurance manual and quality plan to reflect current practices when significant changes occur in the Contractor's program or organization in order to improve its effectiveness or to prevent recurrence of non-conformances.

f) To initiate corrective measures promptly when the quality assurance representative notifies the Contractor of deviations from established requirements.

25.3 DEFINITIONS AND REQUIREMENTS

25.3.1 QUALITY ASSURANCE PROGRAM

The Contractor shall plan, establish, implement and maintain a quality assurance program that complies with the requirements of this chapter.

25.3.2 ORGANISATION

The Contractor shall :

a) Clearly define management policies, objectives and responsibilities for quality

assurance, including the responsibility of each division within a multi-divisional organization. The responsibility and authority for quality of those managing and performing the work and of these auditing and verifying conformance to quality requirements shall be defined and their relationships shown on organization charts.

b) Provide for the review by management of the status and adequacy of the quality assurance program.

c) Appoint a representative who shall report regularly to management at a level that ensures that quality assurance requirements are not subordinated to design, manufacturing, construction or delivery and define his authority to resolve quality matters. Purchaser shall be notified of the appointment in writing.

d) Define the responsibility and authority of personnel who are primarily responsible for quality assurance and their organizational independence during audits and define the responsibility and authority of personnel who are primarily responsible for quality control and their organisational independence to :

- identify and record quality problems
- initiate or recommend or provide solutions through designated channels.
- verify the implementation of dispositions.
- control further processing, delivery or installation of a non-conforming item or service until the deficiency or unsatisfactory condition has been resolved.

Note that, generally, audit personnel shall not be within the pattern of daily activities.

e) Use competent persons for inspection, other than those performing or directly supervising the work being inspected, unless specifically designated otherwise in the quality plan. Such persons shall report to an adequate level of management, excluding direct reports to supervisors responsible for producing the work being inspected.

Generally, inspectors shall verify the conformance to the specifications and drawings. In cases of problems or difficulties they shall request clarification from the design or other competent organisations and initiate appropriate measures.

If examinations, being a part of the whole inspections, are performed and documented by works personnel, the extent of the inspections by the independent personnel may be reduced, if such has been provided for by the quality plant.

25.3.3 QUALITY ASSURANCE DOCUMENTS

a) QUALITY ASSURANCE MANUAL

i) The Contractor shall :

- Prepare a quality assurance annual, approved and signed by a senior management official, and submit it for the Purchaser's concurrence before the contract is awarded

or at the latest before the work starts. A quality assurance manual submitted under a previous contract or tender maybe referred to.

- Review and update the manual to reflect current quality assurance polices and procedures and resubmit the resulting manual.

- Implement the program according to the provisions specified in the manual.

ii) The quality assurance manual shall deal as appropriate with the following :

Organization - The manual shall define the organizational measures as specified 25.3.2.

Quality plan - The manual shall identify the group responsible for the quality plant specified in 25.3.3 (b) and define its main principles and features in adequate procedures.

Quality assurance procedures - Documented quality assurance procedures as specified in 25.3.3(c) shall be included or shall be outlined and cross- referenced. Referenced QA procedures shall be made available to the quality assurance representative.

Manual review - A statement shall be incorporated for reviewing and updating the manual as specified in 25.3.3. (a)(i).

b) <u>QUALITY PLAN</u>

i) The Contractor shall :

- Plan the inspection and test activities

- Identify in the quality plan the inspections and tests to be performed on the items listed in the contract, in compliance with contractual and/or technical requirements.

- Submit the plan for the Purchaser's concurrence following the award of the contract and before the work starts. Referenced inspection and test specifications and/or procedures shall be made available to the quality assurance representative during the implementation of the quality plan.

- Update the plan during the life of the contract to reflect current conditions of manufacturing, construction, inspecting and testing and resubmit the plan to the Purchaser.

b) ii) The quality plan may be of any format to suit the Contractor's system. The quality plan shall deal as appropriate with :

- Identification of the characteristics or items to be inspected and tested.

- Identification of required inspection, test and special process operations and their

relative location in the construction cycle. The Contractor may include additional in-process inspection points for his own evaluation of quality which will not be subject to acceptance and witness by the quality assurance representative.

- Reference to inspection, test and special process procedures, standards, acceptance criteria and sampling plan, if any.

- Indication of hold points beyond which the activity shall not proceed until the required inspections or tests have shown satisfactory results and have been documented.

- Provisions for the Purchaser to insert witness points at which activities are to be observed. The activity may nevertheless proceed beyond a witness point should the Purchaser fail to attend in spite of due notification.

b) iii) The quality plans for subcontracted items, when concurred with by the Contractor, shall be submitted to the Purchaser as applicable, for concurrence & insertion of witness points.

c) <u>QUALITY ASSURANCE PROCEDURES</u>

The Contractor shall have procedures for the following specific requirements should they apply to the contract :

Document control	Cl.25.3.3
Design Control	Cl.25.3.5
Procurement	Cl.25.3.6
Measuring and testing equipment	Cl.25.3.7
Inspection and test	Cl.25.3.8
In-process inspection	Cl.25.3.9
Final inspection	Cl.25.3.10
Inspection status	Cl.25.3.11
Identification and traceability	Cl.25.3.12
Preservation, handling and storage	Cl.25.3.13
Construction	Cl.25.3.14
Special processes	Cl.25.3.15
Quality records	Cl.25.3.16
Non-conformances	Cl.25.3.17
Corrective actions	Cl.25.3.18

Each QA procedure shall define, as applicable, such things as: its purpose and scope; who is responsible for what; how all steps are to be performed; what materials, equipment and documentation are to be used; how it is all controlled.

Forms used shall be exhibited.

QA procedures shall be updated when necessary.

25.3.4 SPECIAL REQUIREMENTS

The Contractor shall

a) Establish measures to ensure that all essential quality related documents including but not limited to those listed below are reviewed for adequacy and approved for release by authorized personnel.:

i) Quality assurance manual required by 25.3.3 (a)

ii) Quality plan required by 25.3.3 (b)

iii) Quality assurance procedures required by 25.3.3(c)

iv) Design documents required as a consequence of 25.3.5

v) Procurement documents required by 25.3.6

vi) Calibration procedures required by 25.3.7

vii) Inspection and test procedures required by 25.3.8

viii) Manufacturing documents required by 25.3.13

ix) Special process procedures required by 25.3.15

b) Establish distribution lists for the above mentioned documents, update and maintain them in the current form to assure that the proper personnel are issued with all the documents necessary to perform the work.

c) Make the applicable issues of these documents available at areas where these activities are performed.

d) Establish and update lists of applicable documents for construction and distribute them systematically. Controlled distribution is required for these lists only.

e) Ensure that changes to documents receive the authorizations by the same organizations as the initial documents unless other organizations are specifically designated. Maintain a record of changes as they are made. Written notes or documents are acceptable provided that they are made by authorized persons according to established procedures. Documents shall be revised and re-issued after a practical number of changes have been issued.

25.3.5 DESIGN CONTROL

a) General

The supplier shall establish and maintain documented procedures to control and verify

the design of the product in order to ensure that the specified requirements are met.

b) Design and development planning

The supplier shall prepare plans for each design and development activity. The plans shall describe or reference these activities, and define responsibility for their implementation. The design and development activities shall be assigned to qualified personnel equipped with adequate resources. The plans shall be updated as the design evolves.

c) Organizational and technical interfaces

Organizational and technical interfaces between different groups which input into the design process shall be defined and the necessary information documented transmitted and regularly reviewed.

d) Design input.

Design input requirements relating to the product, including applicable statutory and regulatory requirements, shall be identified, documented and their selection reviewed by the supplier for adequacy. In complete, ambiguous or conflicting requirements shall be resolved with those responsible for imposing these requirements.

Design input shall take into consideration the results of any contract review activities.

e) Design output

Design output shall be documented and expressed in terms that can be validated against design input requirements.

Design output shall :

i) Meet the design input requirements.

ii) Contain or make reference to acceptance criteria;

iii) Identify those characteristics of the design that are crucial to the safe and proper functioning of the product (e.g. operating, storage, handling, maintenance and disposal requirements).

Design output documents shall be reviewed before release.

f) Design review

At appropriate stages of design, formal documented reviews of the design results shall be planned and conducted. Participants at each design review shall include representatives of all functions concerned with the design stage being reviewed, as well as other specialist personnel, as required. Records of such reviews shall be maintained

.

g) Design verification

At appropriate stages of design, design verification shall be performed to ensure that the design stage output meets the design stage input requirements. The design verification measures shall be recorded.

NOTE : In addition to conducting design reviews, design verification may include activities such as

- performing alternative calculations.
- Comparing the new design with a similar proven design,, if available.
- Undertaking tests and demonstrations, and
- Reviewing the design stage documents before release.

h) Design validation

Design validation shall be performed to ensure that product conforms to defined used needs and / or requirements.

NOTES:

11. Design validation follows successful design verification .
12. Validation is normally performed under defined operating conditions.
13. Validation is normally performed on the final product, but may be necessary in earlier stages prior to product completion.
14. Multiple validations may be performed if there are different intended uses.

i) Design changes

All design changes and modifications shall be identified, documented, reviewed and approved by authorized personal before their implementation.

25.3.6 PROCUREMENT

a) Selection of Subcontractors

The Contractor shall identify items to be procured. He shall undertake the following :

i) Determine for these subcontracted items the applicable Quality Management

Requirements. Classification of these Quality Management Requirements shall be in such a y that the overall quality is not impaired. The classification list shall be submitted to the Purchaser for acceptance.

ii) Evaluate and select subcontractors in accordance with of the applicable Quality Management Requirements with regard to their ability to meet subcontract and quality requirements.

iii) When `off the shelf' items are to be procured, evaluation of subcontractor may not necessarily be required. The Contractor shall nominate to the quality assurance representative those materials, parts and components that belong to this category.

b) SUBCONTRACT REQUIREMENTS

The Contractor shall include in subcontracts the following, as applicable:

i) A clear description of the items or services to be procured including technical data and inspection and test requirements by reference to standards, technical specifications, drawings, etc.

ii) A designation of the applicable Quality Management Requirements to be applied to the items and exceptions, if any.

iii) A designation of the Contractor's QA procedures to be implemented by the subcontractor, if applicable.

iv) Instructions for the submission, retention and disposition of quality records.

v) Requirements for packaging and shipping, where applicable.

vi) A statement related to the right of access to the subcontractor's premises and records for audit and/or surveillance by the Contractor or the Purchaser.

vii) Instructions for notification of witness points.

viii) Requirements for the subcontractor to report non-conformances.

ix) Applicable requirements to be extended to lower tier subcontractors, if any.

Subcontract documents shall be reviewed and approved in accordance with 25.4.4 (a).

All unpriced subcontracts and associated reference data shall made available on request for review by the quality assurance representative.

c) **Amendments to Subcontracts**

The Contractor shall process amendments to sub- contracts in the same way as the initial subcontract and reference the initial subcontract number in the amendments.

d) Verification of the Quality Management System Implemented by the Sub-contractor Refer applicable Quality Management Requirements.

e) **Receiving Inspection**

To the extent that is practical, receiving inspection shall be specified in the quality plan.

The Contractor shall:

i) Identify and inspect items on receipt to ascertain that they comply with contractual requirements. In determining the amount or nature of receiving inspection, consideration shall be given to the surveillance exercised at source and documented evidence of quality conformance. Receiving inspection shall cover as a minimum: verification of deterioration or damage during transport, identification control, review of required documentation.

ii) Initiate corrective action with sub-contractors when non-conforming items are received, as required by the nature and frequency of non-conformances.

iii) Hold incoming items until the required inspection and/or test have been completed or the necessary inspection and/or test reports have been received and verified except when items are released under positive recall.

25.3.7 **MEASURING AND TESTING EQUIPMENT**

All measuring and testing equipment and devices used to verify characteristics that can affect item quality shall be controlled and maintained. At prescribed intervals, or prior to use, they shall be calibrated and adjusted against certified equipment having a known valid relationship to nationally recognized standards. Where no national standards exist, the basis employed for calibration shall be documented.

No special calibration and control measures are necessary on rulers, tape measures, levels and other such devices, if normal commercial practices provide for adequate accuracy and/or if large tolerances are allowed for the corresponding measurements.

The Contractor shall:

a) Include in calibration procedures; equipment type, frequency of checks, description of check method, acceptance criteria and action to be taken when results are unsatisfactory. Exception will be allowed for measuring and testing equipment for which calibration is simple and does not require a specific detailed procedure. The Contractor shall identify those types of measuring equipment for which he has not

provided calibration procedures.

b) Identify measuring and testing equipment with a tag, sticker, or other suitable indicator to show the calibration status.

c) Maintain calibration records for measuring and testing equipment.

d) Assess and document the validity of previous inspection and test results when measuring and testing equipment are found to be out of calibration.

For concreting and earthwork activities :

e) The above mentioned requirements are mandatorily applicable only to the following equipment and instruments :

- laboratory scale
- concrete batching plant
- compression test machine
- tensile test machine
- prestressing pressure gauge
- soil-cement batching plant
- gauge for mechanical splicing
- grout batching machine

For all other equipment and instruments, the requirements are non-mandatory but they may be used as a guide.

25.3.8 INSPECTION AND TEST

a) The Contractor shall provide for the performance of inspections and tests as specified in the quality plan. These inspections and tests shall be carried out in accordance with written procedures that define the method, the materials, instruments or equipment to be used and acceptance/rejection criteria.

The Contractor shall amend the selected inspection methods in cases where their unsuitability is demonstrated.

b) Inspections and tests shall be documented on inspection and test reports that identify as a minimum the item inspected or tested, applicable drawings, specifications or procedures, the date of inspection or test, the inspector, tester or data recorder, the type of observation, the results, the acceptability and the action taken in connection with any deficiencies identified.

25.3.9 IN-PROCESS INSPECTION

The Contractor shall:

a) Identify, inspect and/or test items as required by the quality plan.

b) Monitor process methods, where inspection is not feasible.

c) Hold items until the required inspections and/or tests have been completed or necessary reports have been received and verified except when items are released under positive recall. Release under positive recall shall not preclude (a) above.

For concreting activities :

i) The Contractor shall establish adequate measures for preconcreting, in-process and post-concreting inspections to be performed as applicable.

ii) A part of these inspections and the documentation thereof may be delegated to the works personnel. In such cases, the independent inspections can be reduced to an extent to be defined in the quality plan or in the inspection procedures.

This applies particularly to the case where a specialist is incorporated into the work staff for difficult or sophisticated tasks such as reinforcement placing, prestressing, etc.

iii) Such measures do not preclude complete independent inspections to be performed on a programd basis or as a consequence of results obtained.

25.3.10 **FINAL INSPECTION**

The Contractor shall :

a) Identify, inspect and/or test the completed item as required by the quality plan.

b) Verify that the item has been inspected at all points shown in the quality plan and that the records are adequate and complete.

25.3.11 **INSPECTION STATUS**

The Contractor shall :

a) Provide means for assuring that required inspections and tests are performed and that the acceptability of items with regard to inspections and tests performed is known throughout manufacturing and construction.

b) Establish and maintain a system for identifying the inspection/acceptance status by means of tags, stamped impressions, or other physical means to be affixed to the item or its container or by means of inspection records.

c) Show the identity of the Contractor and his inspector on any inspection marking used.

d) Provide for measures for controlling status indicators including the authority for application and removal of tags, stamps or other marking.

e) Identify non-conforming items.

25.3.12 IDENTIFICATION AND TRACEABILITY

The Contractor shall establish and maintain as adequate system to :

a) Identify each item (lot, component or part) to the applicable drawing, specification or other technical document, throughout the whole construction process.

b) Assign to each item a unique identification where specific traceability is required by the contract.

c) Record this identification on all process, inspection and test records, where traceability is specified.

d) List the items that do or do not require traceability concerning concrete activities.

25.3.13 PRESERVATION, HANDLING AND STORAGE

The Contractor shall :

a) Establish, maintain and document a system for the preservation, storage and handling of all items from the time of receipt through the entire construction process and subsequent storage to prevent abuse, misuse, damage, deterioration or loss.

b) Periodically inspect stored items for condition and shelf-life expiry.

c) Inspect and test-special handling tools and equipment at specific times to verify that the tools and equipment are adequately maintained and will not damage the items and will ensure safe and adequate handling.

d) Use specific written procedures for lifting of critical or high value items.

25.3.14 CONSTRUCTION

a) The Contractor shall clearly define the responsibilities for the documented preparation of works.

This written preparation shall consist of instructions or work assignments. It shall be established in accordance with the construction schedules and be available to the works and inspection personnel prior to commencement of work. This work instruction will document the following :

- Work methods
- sequence of operations
- workmanship criteria
- type of equipment needed

- special working environment, if any.

For concreting and other common civil work activities, these instructions may be included in drawings, specifications or other design documents.

b) The Contractor shall ensure that prior to release for construction all jigs, fixtures, tooling masters, templates, and patterns used for verifying quality are controlled. The extent and frequency of tool control shall be defined.

25.3.15 SPECIAL PROCESSES

The Contractor shall :

a) Identify those special processes subject to the requirements of this clause. Special processes shall include welding, heat treating and non- destructive examination, as applicable.

b) Establish documented procedures to assure that these processes are accomplished under controlled conditions by qualified personnel using qualified documented procedures and suitable equipment in accordance with applicable codes, standards, specifications, criteria and contractual requirements.

c) Maintain documentation for currently qualified personnel and processes according to the requirement of pertinent codes and standards.

d) Define the necessary qualifications of personnel and procedures for special processes not covered by existing codes or standards, or where item or service quality requirements exceed the requirements of established codes or standards.

e) Not consider concreting as a special process. However, the Contractor shall ensure that foremen and vibrator operators are properly selected from experienced or trained personnel prior to assignment of works and are given regular training by concrete placement experts as needed.

25.3.16 QUALITY RECORDS

The Contractor shall :

a) Maintain quality records as evidence that :

i) The quality assurance program meets the requirements of these Quality Management Requirements (manual, procedures, quality plan).

ii) The items or services meet contractual or other applicable technical requirements (specifications, drawings, calculations, manufacturing, inspection and test procedures).

iii) Personnel and procedures for special processes are qualified as required by 25.3.15.

iv) Measuring and testing equipment is calibrated as required by 25.3.7

v) The procurements meet the requirements of 25.3.6

vi) Corrective actions are being taken and are effective as required by 25.3.18

vii) Audits are performed as required by 25.3.19.

b) Maintain final performance quality records which include as appropriate :

i) as build records
ii) material test reports or certificates
iii) non-destructive examination records or certificates.
iv) inspection and test records.
v) non-conformance reports.
vi) concrete batch plant printout.

Items (iii) and (iv) apply to those operations performed after receipt of materials from the supplier.

c) Identify, index and file quality records for easy retrival.

d) Retain quality records for the time specified in the contract. If not specified, final performance quality records shall be retained for 10 years.

e) Provide a suitable environment for storing of records to minimize deterioration or damage and to prevent loss (the use of a double filing system is an acceptable method).

25.3.17 **NON-CONFORMANCES**

The Contractor is responsible for the identification and disposition of all non-conforming items, including those of sub-contractors. Final acceptance of the Contractor's disposition of those items that violate contractual requirements is the prerogative of the Purchaser. The Contractor shall :

The Contractor shall :

a) Verify NPC certification.

b) Examine NPC supplied items on receipt for completeness and proper type and to detect transit damage. Further receiving inspection is not required unless the Contractor needs actual characteristics for subsequent work or unless specified in the contract. Examination may be deferred until further processing is scheduled if items are in sealed containers or have special preservation or packaging.

c) Control NPC supplied items from receipt onwards according to the requirements of this standard.

d) Report promptly in writing to the quality assurance representative, any NPC supplied items found damaged, lost, non-conforming, or otherwise unsuitable or unnecessary for use either on receipt or while in the Contractor's custody.

25.3.18 **CORRECTIVE ACTION**

The Contractor shall :

a) Investigate the causes of significant or recurring non-conformances and take appropriate action to prevent repetition.

b) Document and have reported to appropriate levels of the Contractor's management causes of significant conditions that adversely affect quality and the corrective action taken.

25.3.19 **VERIFICATION OF QUALITY**

25.3.19.1 **INITIAL EVALUATION**

Quality Assurance Program, Facilities and Physical Resources :

Prior to the award of a contract, and to the performance of the activity, the Purchaser shall evaluate the Contractor's quality assurance program, manufacturing facilities and resources to determine whether the requirements of this section can be met.

In the event of the Contractor not fulfilling all applicable requirements, NPC may award the contract provided that he takes the responsibility for those QA requirements that will not be met by the Contractor. In such a case, the exceptions shall be clearly defined in the contract.

25.3.19.2 **QUALITY PLAN**

NPC shall evaluate the quality plan and all revisions thereto in order to determine its acceptability.

NPC shall indicate witness points on the accepted quality plan.

In addition, NPC shall perform surveillance according to the accepted quality plan.

25.3.19.3 **ACCESS**

The Contractor shall provide for reasonable access of the competent authorities and of NPC to his premises and records for audit and surveillance purposes.

LIST OF ANNEXURES

1. Annexure – 1: Typical details of Bore log data

LIST OF TENDER DRAWINGS

1. Drawing no. KAIGA 5&6/10120/2001/DD- Borehole Location Layout
2. Drawing no. KAIGA 5&6/10000/2001/GA- Main Plant Layout
3. Drawing no. KAIGA5&6/16000/2003 /SK – Excavation Drawings

ANNEXURE – 1

Sohams Foundation Engg. Pvt. Ltd.Mumbai

SFE

Project :- Carrying Out Geo-Technical and Geo-Physical Investigations For Kaiga 5&6,Kaiga Site,PO Kaiga,Karwar, Uttara Kannada Dist. Karnataka State

Format No : SFE/KAIGA5&6/RD/01

Client:-NPCIL

Job No :- | Created By :- HPG | Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 110
Sheet : 1 OF 4
Feature: =

Location : TB-5 | Co-Ordinates :X-440226.0394,Y-1642944.9270 | GWL:-1.280m
Angle with vertical : 0° | Collar Elevation : | Existing Ground
Total depth : 56.10m | Type (s) of core barrel : D.Tube | Elevation : 96.356m
Started :3 / 5 / 2018 | Completed : 8 / 7 / 2018 | Drilling Agency : SFE

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10 mm	<10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D . %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
0.00																												
1.50	94.856	REDDISH COLOUR MURRUM																10	15	26		41						
1.95																												
4.50	91.856	BROWNISH SOIIL																11	17	23		40						
4.95																												
7.50	88.856	BOULDER												NX Diamond														
9.00	87.356	HIGHLY WEATHERED LIGHT GREY FRACTURED GRANITE			2,3		SP,1,SP		62						16													
10.50	85.856	GRAYISH HIGHLY FRACTURED HIGLY WEATHERED GRANITE			4,5	10	SP,6,7,8,9		72						53.33													
12.50	83.386				13,15	12,14	11,SP,16		58						29.5													
13.00	83.356				17	18,19	SP,20		78						78													
14.00	82.356					21	22,23,24		97						94													
15.00	81.356				SP	25,27	26		23						15													
17.50	78.856	WHITISH TO GRAYISH SLIGHTLYFRACTURED SLIGHTLY WEATHERED GRANITE			28,SP	29,31,33	30,32		88						86													
									82						86													

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Client:-NPCIL

Job No :- | Created By :- HPG | Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 110

Sheet : 2 OF 4

Feature: =

Location : TB-5 | Co-Ordinates :X-440226.0394,Y-1642944.9270 | GWL:-1.280m

Angle with vertical : 0° | Collar Elevation : | Existing Ground

Total depth : 56.10m | Type (s) of core barrel : D.Tube | Elevation : 96.356m

Started :3 / 5 / 2018 | Completed : 8 / 7 / 2018 | Drilling Agency : SFE

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10 mm	<10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D . %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
18.50	77.856	WHITISH TO GRAYISH SLIGHTLYFRACTURED SLIGHTLY WEATHERED GRANITE		37,41	36,38,42	34,35,39 40,43	SP,SP				82			NX Diamond	59													
20.00	76.356			46,47	48,50,52,53	44,51	45,49,54				83				73.33													
21.50	74.856	GRAYISH TO WHITISH SLIGHTLY FRACTURED SLIGHTLY WEATHERED GRANITE			SP,58,59,62	60,61,63	55,56,57				80.66				72													
23.00	73.356				65,66,67,69 SP,72	68,SP,SP,70,71	64,73				70.66				52													
25.00	71.356				75,76,77,80	74,78,79	SP,81,SP,82,83				88.50				81.5													
27.50	68.856				87,90,92	86,88,89,91,93	SP,84,85				67.33				48.66													
29.00	67.356				96	97	94,95,98				91.33				91.33													
30.50	65.856					99,102,103	100,101,104,SP				99.33				83.33													
32.00	64.356	GRAYISH TO LIGHT GREY SLIGHTLY WEATHERED FRESH GRANITE			106	105,108	107,109				67.33				67.33													
33.50	62.856				111,112	SP,113,115	110,114				95.33				64													
35.50	60.856				118	117,119,121	116,120				71				63.5													

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Format No : SFE/KAIGA5&6/RD/01

Client:-NPCIL

Job No :- | Created By :- HPG | Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 110

Sheet : 3 OF 4

Feature: =

Location : TB-5	Co-Ordinates :X-440226.0394,Y-1642944.9270	GWL:-1.280m
Angle with vertical : 0°	Collar Elevation :	Existing Ground
Total depth : 56.10m	Type (s) of core barrel : D.Tube	Elevation : 96.356m
Started :3 / 5 / 2018	Completed : 8 / 7 / 2018	Drilling Agency : SFE

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10 mm	<10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D. %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
37.00	59.356	GRAYISH TO LIGHT GREEN SLIGHTLY WEATHERED FRESH GRANITE				SP,126,127	122,123,124				94.66			NX Diamond	90.66													
40.00	56.356	GRAYISH TO WHITISH SLIGHTLY FRACTURED MODERATELY TO SLIGHTLY WEATHERED GRANITE		141,SP,142,143,144	137,138,SP,139,140,130,SP,133	136,SP,128,SP,129,131,SP	SP,132,134,135,SP				73				40													
41.00	55.356				145	146,147 148	60				83				32													
43.00	43.356					149,150,152,SP	151,153,154				70				63.5													
45.00	51.356	GRAYISH TO WHITISH MODERATELY FRACTURED MODERATELY WEATHERED GRANITE			SP,158,161	SP	155,156,157,159 160,162				96.5				74.5													
48.00	48.356				175,176,177,178,179,163,164 165,166	167 TO 170,172,173,180,181	SP,171,174				60.33				44.66													
49.50	46.856				184,185	182,186,187,SP	183			24.66					10													
51.00	45.356	GRAYISH TO WHITISH SLIGHTLY WEATHERED GRANITE			188,190,192 193 191,	189,SP					71.33				51.33													
53.50	42.856			SP	203,204,195,196,197 206,198,200,201 205,199	202,SP,194,SP,207					80.66				74													

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Project :- Carrying Out Geo-Technical and Geo-Physical Investigations For Kaiga 5&6,Kaiga Site,PO Kaiga,Karwar, Uttara Kannada Dist. Karnataka State

Format No : SFE/KAIGA5&6/RD/01

Client:-NPCIL

Job No :- | Created By :- HPG | Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 110

Sheet : 4 OF 4

Feature: =

Location : TB-5 | Co-Ordinates :X-440226.0394,Y-1642944.9270 | GWL:-1.280m

Angle with vertical : 0° | Collar Elevation : | Existing Ground Elevation : 96.356m

Total depth : 56.10m | Type (s) of core barrel : D.Tube | Drilling Agency : SFE

Started :3 / 5 / 2018 | Completed : 8 / 7 / 2018

Depth , m	Elevation	Lithoiog: Description	Size of core pieces: < 10 mm	<10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D . %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
		SLIGHTLY WEATHERED LIGHT GREY GRANITE			216.221	218.219.220	215.217				92.88			NX Diamond	81.10													
56.10	40.256																											

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	Logged By (Geologist)	Checked By (QA)	Civil	(QA)

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Format No:- SFE / KAIGA 5 & 6 / RD / 01

Client:-NPCIL

Job No :-

Created By :-

Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 113

Sheet : 1 of 4

Feature: =

Location : TB-6

Co-Ordinates :X-440322.6295,Y1642970.8180

GWL:- 4.300m

Angle with vertical : 0°

Collar Elevation :

Existing Ground

Total depth : 65m

Type (s) of core barrel : D.Tube

Elevation : 97.745m

Started : 2 / 7 / 2018

Completed : 3 / 8 / 2018

Drilling Agency : S.F.E. Pvt Ltd.

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D. %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
0.00														NX Diamond														
1.50	96.245	REDDISH COLOUR MURUM																8	9	11	-	20					3.17	
1.95																												
4.50	93.245	RED COLOUR LATERITIC SOIL																10	12	21	-	33					1.18	
4.95																											0.48	
7.50	90.245																											
10.5	87.245																										0.44	
13.5	84.245	Sand																									0.56	
16.0	81.745																										0.57	
18.5	79.245	LIGHT GREEN HIGHLY WEATHERED GRANITE		1	5,3,4	SP,SP,6			54.8						15.6													
22.5	75.245	LIGHT GREEN MODERATELY TO HIGHLY WEATHERED GRANITE			7,9,11,13	8,18,12	SP		17						7.25													

SIGNATURE	Sohams		NPCIL	
	Logged By (Geologist)	Checked By (QA)	Civil	(QA)

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Format No:- SFE / KAIGA 5 & 6 / RD / 01

Client:-NPCIL

Job No :-

Created By :-

Created On:-

Hole No :- 113

Sheet : 2 of 4

Feature: =

GEOLOGICAL LOG OF BORE HOLE

Location : TB-6

Co-Ordinates :X-440322.6295,Y1642970.8180

GWL:- 4.300m

Angle with vertical : 0°

Collar Elevation :

Existing Ground Elevation : 97.745m

Total depth : 65m

Type (s) of core barrel : D.Tube

Drilling Agency : S.F.E. Pvt Ltd.

Started : 2 / 7 / 2018

Completed : 3 / 8 / 2018

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Blt	R.Q.D . %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
22.5										48.5																		
24.5	73.245	LIGHT GRAY MODERATELY WEATHERED GRANITE		14,19	15,16,17	SP,18									21.5													
26.0	71.745			SP,20,22	21,23,24,25	SP				41.33					28.66													
27.0	70.745			26 TO 34	35					64					64													
29.0	68.745		41	36,37,38,39,42	40	SP				26.5				NX Diamond	9.5													
30.5	67.245	BROWN TO GRAY MODERATELY WEATHERED GRANITE		43,SP,44		SP				29.3					NIL													
32.0	65.745			45		SP				16					NIL													
33.5	64.245			SP,46,47,48	49,50	SP				33.33					10.6													
35.0	62.745	BROWNISH HIGHLY WEATHERED GRANITE			51	SP				16					NIL													
36.5	61.245			52,SP		SP				22.66					NIL													
38.0	59.745	LIGHT GRAY TO GREEN MODERATELY WEATHERED GRANITE		SP,53,54		SP				22.66					NIL													
39.0	58.745		59	SP,55,56,58	57	SP				45					21													

SIGNATURE	Sohams		NPCIL	
	Logged By (Geologist)	Checked By (QA)	Civil	(QA)

Sohams Foundation Engg. Pvt. Ltd.Mumbai

SFE

Project :- Carrying out Geo-Technical and Geo-Physical investigasions for Kaiga 5&6,Kaiga Site, Karwar, Uttara Kannada Dist.Karnataka State

Format No:- SFE / KAIGA 5 & 6 / RD / 01

Client:-NPCIL

Job No :- | Created By :- | Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 113
Sheet : 3 of 4
Feature: =

Location : TB-6 | Co-Ordinates :X-440322.6295,Y1642970.8180 | GWL:- 4.300m
Angle with vertical : 0° | Collar Elevation : | Existing Ground
Total depth : 65m | Type (s) of core barrel : D.Tube | Elevation : 97.745m
Started : 2 / 7 / 2018 | Completed : 3 / 8 / 2018 | Drilling Agency : S.F.E. Pvt Ltd.

Depth , m	Elevation	Description (Litholog)	Size of core pieces: < 10mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D. %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
40.0	57.745	LIGHT GRAY TO GREEN MODERATELY WEATHERED GRANITE			60,61		SP			62				NX Diamond	NIL													
41.0	56.745				62,66	64,65	SP,63			69					47													
42.5	55.245				69	63,67,70	SP			38.66					NIL													
44.0	53.745				81,82,80	SP,71 TO 75	75,77,78,79			49.33					46.66													
45.5	52.245		SP		83,84,85,86		SP			32					12													
47.0	50.745			89	87	SP				35.33					15.33													
48.5	49.245				91,92	90,93	SP			45.33					14													
50.0	47.745	LIGHT GRAY TO GREEN MODERATELY WEATHERED GRANITE			94,95,90,97		SP			40.66					NIL													
51.5	46.245				98		SP			42					NIL													
53.5	44.245				100,103 TO 108	101,102	99,SP			49.5					39.5													
55.0	42.745			109	110	SP			20.66						10													
56.5	41.245				111	SP				49.33					6.66													
										85					39													

SIGNATURE	Sohams		NPCIL	
	Logged By (Geologist)	Checked By (QA)	Civil	(QA)

Sohams Foundation Engg. Pvt. Ltd.Mumbai

SFE

Project :- Carrying out Geo-Technical and Geo-Physical investigasions for Kaiga 5&6,Kaiga Site, Karwar, Uttara Kannada Dist.Karnataka State

Format No:- SFE / KAIGA 5 & 6 / RD / 01

Client:-NPCIL

Job No :-

Created By :-

Created On:-

GEOLOGICAL LOG OF BORE HOLE

Hole No :- 113

Sheet : 4 of 4

Feature: =

Location : TB-6

Co-Ordinates :X-440322.6295,Y1642970.8180

GWL:- 4.300m

Angle with vertical : 0°

Collar Elevation :

Existing Ground

Total depth : 65m

Type (s) of core barrel : D.Tube

Elevation : 97.745m

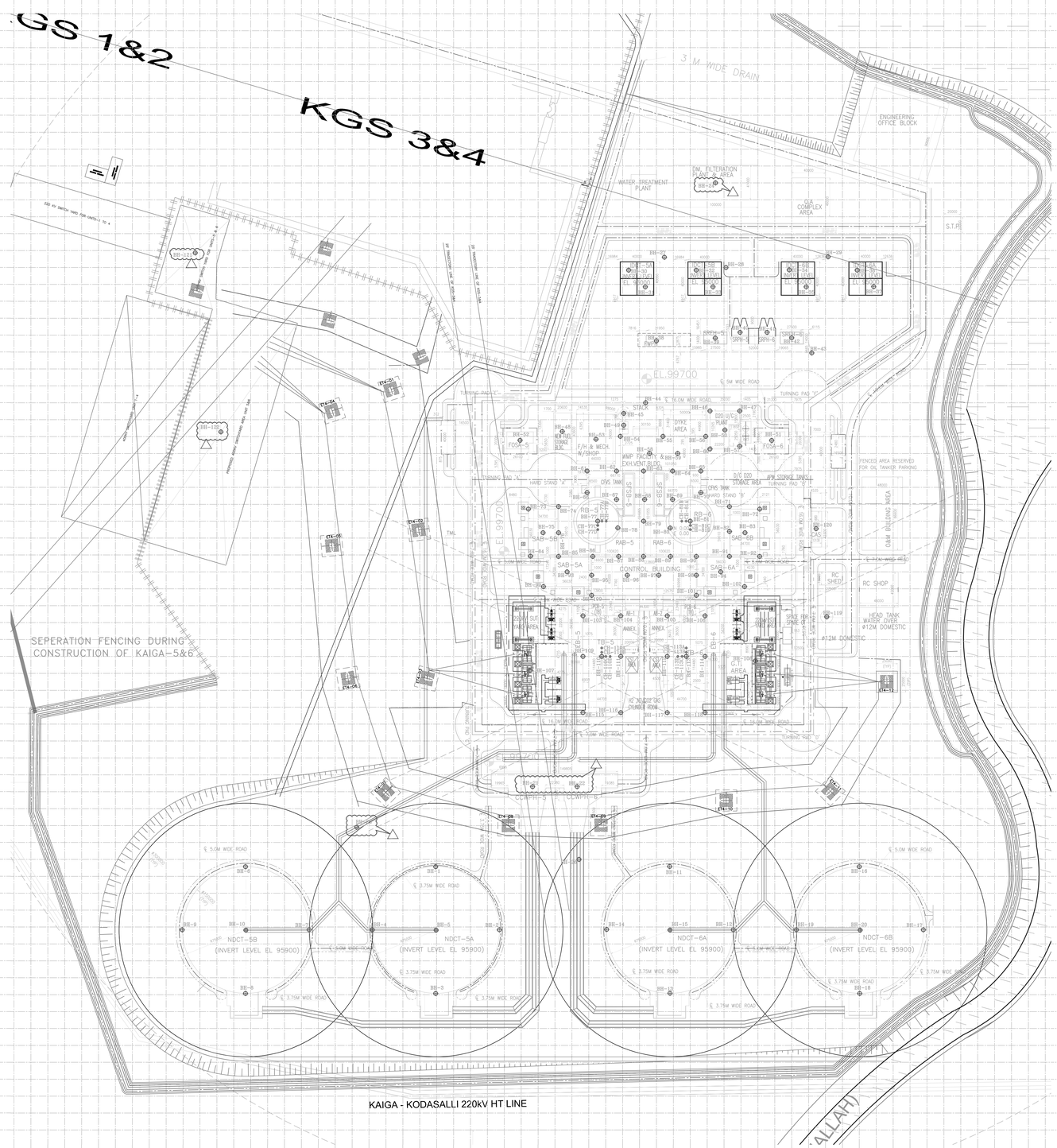
Started : 2 / 7 / 2018

Completed : 3 / 8 / 2018

Drilling Agency : S.F.E. Pvt Ltd.

Depth , m	Elevation	Litholog: Description	Size of core pieces: < 10mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	150 mm	Log	Percent Core recovery: 0-20	20-40	40-60	60-80	80-100	Type of Bit	R.Q.D , %	Facture Frequency per, m	SPT: SPT No	SPT Value: N1	N2	N3	N4	N	Drill Water loss: Partial	Complete	Permeability: Test section	lugeon	Penetration Rate,cm/hr	Special observations & interpretations
57.50	40.245	LIGHT GRAY TO GREEN MODERATELY WEATHERED GRANITE			117,118 SP,119	115 TO 116 SP	112,SP				85			NX Diamond	39													
58.00	39.745					120	SP				50				NIL													
60.50	37.245				SP	121,122,123,124	SP,SP,SP				55.2				12.4													
63.00	34.745				129,130,131	127,128,132,SP	125,126,SP				47.2				31.2													
65.00	32.745				133,134,SP	SP,138,135	136,137,138				54.75				27.75													

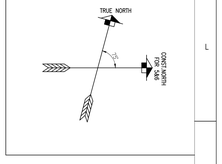
SIGNATURE	Sohams		NPCIL	
	Logged By (Geologist)	Checked By (QA)	Civil	(QA)



DETAILS OF BORE HOLES

BORE HOLE NO.	LOCATION	X-COORD.	Y-COORD.	FOUNDING LEVEL (EL) IN M.	DEPTH OF BORE HOLE (M) FROM FOUNDING LEVEL OR WEATHERED ROCK LEVEL WHICHEVER IS LOWER
BH-1		1M←(5)	11M↑(h2)	92.0	20.0
BH-2		5M←(9)	3M↓(e2)	92.0	20.0
BH-3	NDCT-5A	1M←(5)	1M↑(d2)	92.0	20.0
BH-4		4M←(1)	3M↓(e2)	92.0	20.0
*BH-5		0.5M←(5)	3.5M↓(e2)	92.0	20.0
BH-6		6M←(6)	11M↑(h2)	92.0	20.0
BH-7		9M←(3)	3M↓(e2)	92.0	20.0
BH-8	NDCT-5B	6M←(6)	1.5M↑(a2)	92.0	20.0
BH-9		1M←(10)	3M↓(e2)	92.0	20.0
*BH-10		5.5M←(8)	3.5M↓(e2)	92.0	20.0
BH-11		5M←(19)	11.5M↑(h2)	92.0	20.0
BH-12		11M←(22)	3M↓(e2)	92.0	20.0
BH-13	NDCT-6A	4M←(19)	1.5M↑(a2)	92.0	20.0
BH-14		1M←(15)	3M↓(e2)	92.0	20.0
*BH-15		4M←(19)	3.5M↓(e2)	92.0	20.0
BH-16		(30)	11M↑(h2)	92.0	20.0
BH-17		4M←(34)	3M↓(e2)	92.0	20.0
BH-18	NDCT-6B	0.5M→(30)	1.5M↑(a2)	92.0	20.0
BH-19		1M←(24)	3M↓(e2)	92.0	20.0
*BH-20		1M←(34)	3.5M↓(e2)	92.0	20.0
BH-21	CCWPH-5	6.5M←(11)	6M↑(m2)	92.0	20.0
*BH-22	CCWPH-6	6M→(13)	6M↑(m2)	90.0	20.0
BH-23	CHLORINATION PLANT D/M FILTERATION PLANT AREA	6M→(6)	8M↑(k1)	96.7	20.0
BH-24		10M→(21)	d	96.7	20.0
BH-25		5.5M→(3)	5.5M↑(k2)	94.0	20.0
BH-26		8.5M←(13)	(12)	94.0	20.0
BH-27	TUNNEL	10.5M←(19)	12M↑(1)	92.0	20.0
BH-28		2M→(22)	(1)	92.0	20.0
BH-29		3M→(28)	7M↓(h)	92.0	20.0
*BH-30		7M→(10)	3M↓(i)	96.5	40.0
BH-31	IDCT-5A	6.5M←(7)	2M↓(j)	96.5	40.0
*BH-32		7M←(20)	3M↓(i)	96.5	40.0
BH-33	IDCT-5B	6M→(21)	2M↓(j)	96.5	40.0
*BH-34		2M←(26)	2M↓(i)	96.5	40.0
BH-35	IDCT-6B	2M←(27)	2M↓(j)	96.5	40.0
*BH-36		2M←(30)	3M↓(i)	96.5	40.0
BH-37	IDCT-6A	3M→(24)	2M↑(j)	96.5	40.0
*BH-38	FWPH	(18)	13M↑(n)	89.9	20.0
BH-39	SREH-5	9.5M→(21)	3.5M↓(m)	96.7	20.0
*BH-40	SRPH-5	1M←(23)	3M↑(m)	92.5	20.0
BH-41	SRPH-6	10.5M→(24)	3M↑(m)	92.5	20.0
*BH-42	SREH-6	(26)	3M↓(m)	96.7	20.0
BH-43	PCTL	3.5M→(27)	1M↓(n)	92.0	20.0
BH-44	TUNNEL	7M←(17)	(q)	92.0	20.0
*BH-45	STACK	1M←(16)	7.5M↑(f)	88.5	20.0
BH-46	D2O PLANT	3M→(21)	10M↑(f)	96.7	20.0
BH-47		1.5M←(23)	10M↑(f)	96.7	20.0
*BH-48	NFSB	8.5M←(12)	6M↑(g)	96.7	20.0
BH-49	SMR	1M←(16)	6.5M↓(f)	94.8	20.0
BH-50	D2O PLANT	1M→(22)	7.5M↑(g)	96.7	20.0
*BH-51	FOSA-6	3.5M←(25)	4.5M↓(g)	94.5	20.0
BH-52	FOSA-5	1M←(19)	4.5M↓(g)	94.5	20.0
BH-53	F/M W/SHOP	8.5M→(4)	3M↓(g)	96.7	20.0
*BH-54		2.5M←(16)	(g)	91.0	40.0
BH-55	WMP	8M←(18)	(g)	91.0	40.0
*BH-56		1.5M←(2)	(g)	91.0	40.0
BH-57	D2O PLANT	1.5M←(23)	8.5M↑(t)	96.7	20.0
*BH-58	WMP	8M←(18)	(t)	91.0	40.0
BH-59		5M←(19)	(t)	91.0	40.0
BH-60	D2O PLANT	3.5M→(21)	5.5M↓(t)	96.7	20.0
BH-61		2M→(4)	1M↓(u)	84.0	100.0
BH-62	NB-5	7M←(16)	1M↓(u)	84.0	100.0
BH-63		4.5M→(17)	1M↓(u)	84.0	100.0
BH-64	NB-6	1M←(19)	0.5M↓(u)	84.0	100.0
BH-65		7M←(21)	0.5M↓(u)	84.0	100.0
BH-66		1M←(14)	6.5M↓(v)	84.0	100.0
BH-67	NB-5	7M←(16)	5.5M↓(w)	84.0	100.0
BH-68		6M→(17)	5.5M↓(w)	84.0	100.0
BH-69		0.5M←(19)	5.5M↓(w)	84.0	100.0
BH-70	NB-6	4.5M→(21)	6M↓(v)	84.0	100.0
BH-71		6.5M→(22)	2.5M↓(w)	84.0	100.0

BORE HOLE NO.	LOCATION	X-COORD.	Y-COORD.	FOUNDING LEVEL (EL) IN M.	DEPTH OF BORE HOLE (M) FROM FOUNDING LEVEL OR WEATHERED ROCK LEVEL WHICHEVER IS LOWER
BH-72	SAB-6B	2M→(24)	5.5M↓(w)	90.0	35.0
BH-73	SAB-5B	9M←(13)	5.5M↓(w)	90.0	35.0
BH-74	NB-5	4M→(12)	2.5M↓(w)	84.0	100.0
*BH-75	SAB-5B	5.5M←(13)	6M↑(y)	90.0	35.0
BH-76		4.5M→(12)	6M↑(y)	84.0	100.0
*#BH-77	NB-5	10.5M→(14)	(x)	84.0	100.0
BH-78		5.5M←(16)	8M↓(x)	84.0	100.0
*BH-79		4.5M→(17)	(x)	84.0	100.0
BH-80		3.5M←(19)	8M↓(x)	84.0	100.0
*#BH-81	NB-6	(20)	(x)	84.0	100.0
BH-82		6M→(23)	6M↓(y)	84.0	100.0
*BH-83	SAB-6B	4.5M→(23)	6M↓(y)	90.0	35.0
BH-84	SAB-5B	9M←(11)	1.5M↓(z)	90.0	35.0
BH-85		4M→(12)	1.5M↓(z)	84.0	100.0
BH-86	NB-5	4.5M→(14)	1.5M↓(z)	84.0	100.0
BH-87		4.5M←(16)	1.5M↓(z)	84.0	100.0
BH-88		4.5M←(17)	1.5M↓(z)	84.0	100.0
BH-89		3.5M←(19)	1.5M↓(z)	84.0	100.0
BH-90	NB-6	7M→(20)	1.5M↓(z)	84.0	100.0
BH-91		6.5M→(22)	1.5M↓(z)	84.0	100.0
BH-92	SAB-6B	2M→(24)	1.5M↓(z)	90.0	35.0
*BH-93	SAB-5A	5.5M←(13)	(y2)	90.0	35.0
*BH-94	SAB-6A	3.5M←(22)	(z2)	90.0	35.0
*BH-95		3.5M←(14)	4M↓(z2)	90.0	45.0
BH-96	CB	5.5M←(16)	4M↓(y2)	90.0	45.0
*BH-97		2.5M→(18)	4M↓(z2)	90.0	45.0
BH-98		7M→(20)	4M↓(z2)	90.0	45.0
BH-99	SAB-5A	6M→(11)	2.5M↑(y2)	90.0	35.0
BH-100		3.5M→(14)	7.5M↓(y2)	90.0	45.0
BH-101	CB	7M→(20)	7.5M↓(y2)	90.0	45.0
BH-102	SAB-6A	4M→(23)	2.5M↑(y2)	90.0	35.0
BH-103	TB-5	6.5M←(14)	8M↑(w2)	90.0	48.0
BH-104		2M←(16)	8.5M↑(w2)	90.0	48.0
BH-105	TB-6	7M←(19)	8M↑(w2)	90.0	48.0
BH-106		2.5M←(21)	8M↑(w2)	90.0	48.0
BH-107	GT AREA-5	10M→(10)	3.5M↑(t2)	96.7	20.0
BH-108	GT AREA-6	2.5M←(24)	5.5M↓(u2)	96.7	20.0
BH-109		7M←(14)	(u2)	90.0	48.0
*#BH-110	TB-5	4.5M←(13)	(u2)	90.0	48.0
BH-111		2M←(16)	(u2)	90.0	48.0
BH-112		7M←(19)	(u2)	90.0	48.0
*#BH-113	TB-6	4.5M←(20)	(u2)	90.0	48.0
BH-114		2.5M←(21)	(u2)	90.0	48.0
BH-115	TB-5	7M←(14)	6.5M↑(t2)	90.0	48.0
BH-116		2M←(16)	6.5M↑(t2)	90.0	48.0
BH-117	TB-6	7M←(19)	6.5M↑(t2)	90.0	48.0
BH-118		2.5M←(21)	6M↑(t2)	90.0	48.0
BH-119	OHT	1.5M←(28)	6.5M↑(w2)	94.7	20.0
BH-120	CAS	9M→(27)	11M↑(y)	95.7	20.0
BH-121	220 KV SY	5.5M←(9)	3M↓(h)	96.7	20.0
BH-122	400 KV SY	5M←(8')	5.5M↓(s)	96.7	20.0
CH-77A		4.5M←(15)	(x)	84.0	100.0
CH-77B	RECEIVER HOLES FOR SOURCE HOLE BH-77 (RB-5)	0.5M←(15)	(x)	84.0	100.0
CH-77C		9.5M←(15)	5M↓(x)	84.0	100.0
CH-77D		9.5M←(15)	10M↓(x)	84.0	100.0
CH-81A		5M←(20)	(x)	84.0	100.0
CH-81B	RECEIVER HOLES FOR SOURCE HOLE BH-81 (RB-6)	10M←(20)	(x)	84.0	100.0
CH-81C		20	5M↓(x)	84.0	100.0
CH-81D		20	10M↓(x)	84.0	100.0
CH-110A		4.5M←(15)	5M↑(u2)	90.0	48.0
CH-110B	RECEIVER HOLES FOR SOURCE HOLE BH-110 (TB-5)	4.5M←(15)	10M↑(u2)	90.0	48.0
CH-110C		0.5M←(15)	(u2)	90.0	48.0
CH-110D		5.5M←(15)	(u2)	90.0	48.0
CH-113A		4.5M←(20)	5M↑(u2)	90.0	48.0
CH-113B	RECEIVER HOLES FOR SOURCE HOLE BH-113 (TB-6)	4.5M←(20)	10M↑(u2)	90.0	48.0
CH-113C		9.5M←(20)	(u2)	90.0	48.0
CH-113D		14.5M←(20)	(u2)	90.0	48.0



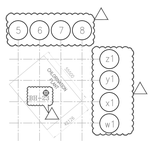
LEGENDS:-

- MAIN PLANT BOUNDARY
- PROPERTY BOUNDARY FENCING
- DOUBLE FENCING FOR PHYSICAL PROTECTION
- PLANT ROADS
- 400KV O/H TRANSMISSION LINES
- EXCLUSION ZONE
- SEPERATION FENCE BETWEEN KGS 1 TO 4 & KAIGA 5&6 DURING CONSTRUCTION
- BOREHOLES TO BE DRILLED
- BOREHOLES TO BE DRILLED FOR CONDUCTING CHST.

BH	BOREHOLE
EGL	EXISTING GROUND LEVEL
FGL	FINISHED GRADE LEVEL
NB	NUCLEAR BUILDING
RB	REACTOR BUILDING
RAB	REACTOR AUXILIARY BUILDING
SAB	STATION AUXILIARY BUILDING
CB	CONTROL BUILDING
SFSB	SPENT FUEL STORAGE BAY
TB	TURBINE BUILDING
ET4	400 KV TRANSMISSION LINE TOWER
GT	GENERATOR TRANSFORMER
SUT	START UP TRANSFORMER
UT	UNIT TRANSFORMER
TML	TURBINE MISSILE LINE
FOSA	FUEL OIL STORAGE AREA
PWPH	PLANT WATER PUMP HOUSE
FWPH	FIRE WATER PUMP HOUSE
SRPH	SAFETY RELATED PUMP HOUSE
CCWPH	CONDENSER COOLING WATER PUMP HOUSE
BOP	BURNT OIL PIT
NDCT	NATURAL DRAFT COOLING TOWER
IDCT	INDUCED DRAFT COOLING TOWER
DG	DIESEL GENERATOR
SREH	SAFETY RELATED ELECTRICAL HOUSE
CAS	CENTRAL ALARM STATION/CONTROL ACCESS SYSTEM
PPS	PHYSICAL PROTECTION SYSTEM
S.T.P.	SEWAGE TREATMENT PLANT
CPVS	CONTAINMENT FILTERED VENTING SYSTEM
DOT	DAY OIL TANK
MGH	MAIN GUARD HOUSE
STF	SPECIAL TASK FORCE
220 KV SY	220 KV SWITCH YARD
400 KV SY	400 KV SWITCH YARD

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
2. THE PLANT LAYOUT SHOWN IS INDICATIVE AND THE DIMENSIONS SHALL NOT BE SCALED.
3. FINISHED GRADE LEVEL FOR THE OPERATING ISLAND (AREA WITHIN PPS FENCE) SHALL BE RL 41300 ABOVE MSL WHICH CORRESPONDS TO EL. 99700.
4. DEPTHS OF BORE HOLES HAVE BEEN CALCULATED BASED ON REQUIREMENT FROM 'FOUNDING LEVEL', DEPTH OF DRILLING FROM EXISTING GROUND LEVEL SHALL BE CALCULATED BASED ON CONTOUR SURVEY AVAILABLE AT SITE.
5. ALL THE BORE HOLES SHALL BE OF 5x SIZE IN SOIL AND Nx SIZE IN ROCK STRATA.
6. SPT SHALL BE CONDUCTED IN THESE BOREHOLES AT 3M INTERVAL FROM EGL UP ROCK LEVEL.
7. (*) THESE BORE HOLES ARE TO BE COMPLETED DURING PHASE-1 AS THE BORE HOLE DATA IS REQUIRED FOR PREPARATION OF SER OF KAIGA - 5&6
8. (#) SOURCE HOLE FOR CROSS HOLE SEISMIC TEST.
9. LARGER DRILLING DEPTH HAS BEEN CONSIDERED FOR BORE HOLES ON THE BOUNDARY OF TWO ADJACENT BUILDINGS.
10. DUE TO SITE CONSTRAINTS, LOCATION OF BOREHOLES MAY BE MARGINALLY SHIFTED WITH APPROVAL OF ENGINEER.
11. "AS BUILD" DRAWING SHOWING ACTUAL LOCATIONS SHALL BE PREPARED BY EXECUTOR ON COMPLETION OF FIELD WORK.
12. GEOTECHNICAL INVESTIGATIONS/BOREHOLES IN INFRASTRUCTURE AREA ARE NOT COVERED IN THIS DRAWING.



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2	R1	FOR CONSTRUCTION	06-04-2018	
1	R0	FOR CONSTRUCTION	09-03-2018	

DRAWING ISSUED FOR

NUCLEAR POWER CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

TITLE :- KAIGA-5&6
GEOTECHNICAL INVESTIGATIONS BOREHOLE LAYOUT FOR MAIN PLANT STRUCTURES

DES'D. – DATE		DR'N. DATE	APL	REV'D. DATE
DES.CHK'D.– DATE		DRG.CHK'D. DATE		APP'D. DATE
PROJECT	KAIGA-5 & 6			SCALE – 1:1
				PROJECTION

DRG. No. KAIGA-5 & 6/10120/2001/DD — REV. No. R1

FLOPPY'D "NO" — FILE NAME: KAIGA5_10120_2001_DD_R1

DRG. TO BE READ IN CONJUNCTION WITH DCN/FCN/ECN, IF ANY.

DRG. No. KAIGA-5&6/10120/2001/DD

No.	LOCATION	DESCRIPTION	DR'N.	DES'D.	D.CHK'D.	REV'D.	APP'D.
1	R1	1. GRID NUMBERS OF CHLORINATION PLANT CORRECTED TO SUIT MAIN PLANT LAYOUT. 2. BOREHOLE NUMBERS IN LAYOUT REVISED TO SUIT THE TABLE. 3. ADDITION OF BOREHOLES IN 220 & 400 kV SWITCHYARD.	KAPS 06/04/2018				

REVISIONS — SIGNATURE WITH DATE (CONSULTANT) — SIGNATURE WITH DATE (NPCIL)

MAIN PLANT LAYOUT — KAIGA-5&6/10000/2001/GA

REFERENCE DRAWINGS — DRAWING No.

DO NOT SCALE THE DRAWING.

UNLESS OTHERWISE STATED :-
ALL DIMENSIONS ARE IN mm.
MACHINE ALL OVER.
SURFACE FINISH TO BE 3.2/ OR BETTER.
REMOVE ALL BURRS.
REMOVE ALL EXTERNAL SHARP CORNERS AND EDGES BY CHAMFERING TO 0 . 15 / 0 . 40 X 45°
ROUND ALL INTERNAL CORNERS AND EDGES TO R 0 . 15 / 0 . 40.
TOLERANCES ON RADII AND CHAMFERS (IS : 2102)

RADII AND CHAMFERS	0.5–3	3–6	6–30
TOLERANCES	± 0.2	± 0.5	± 1.0

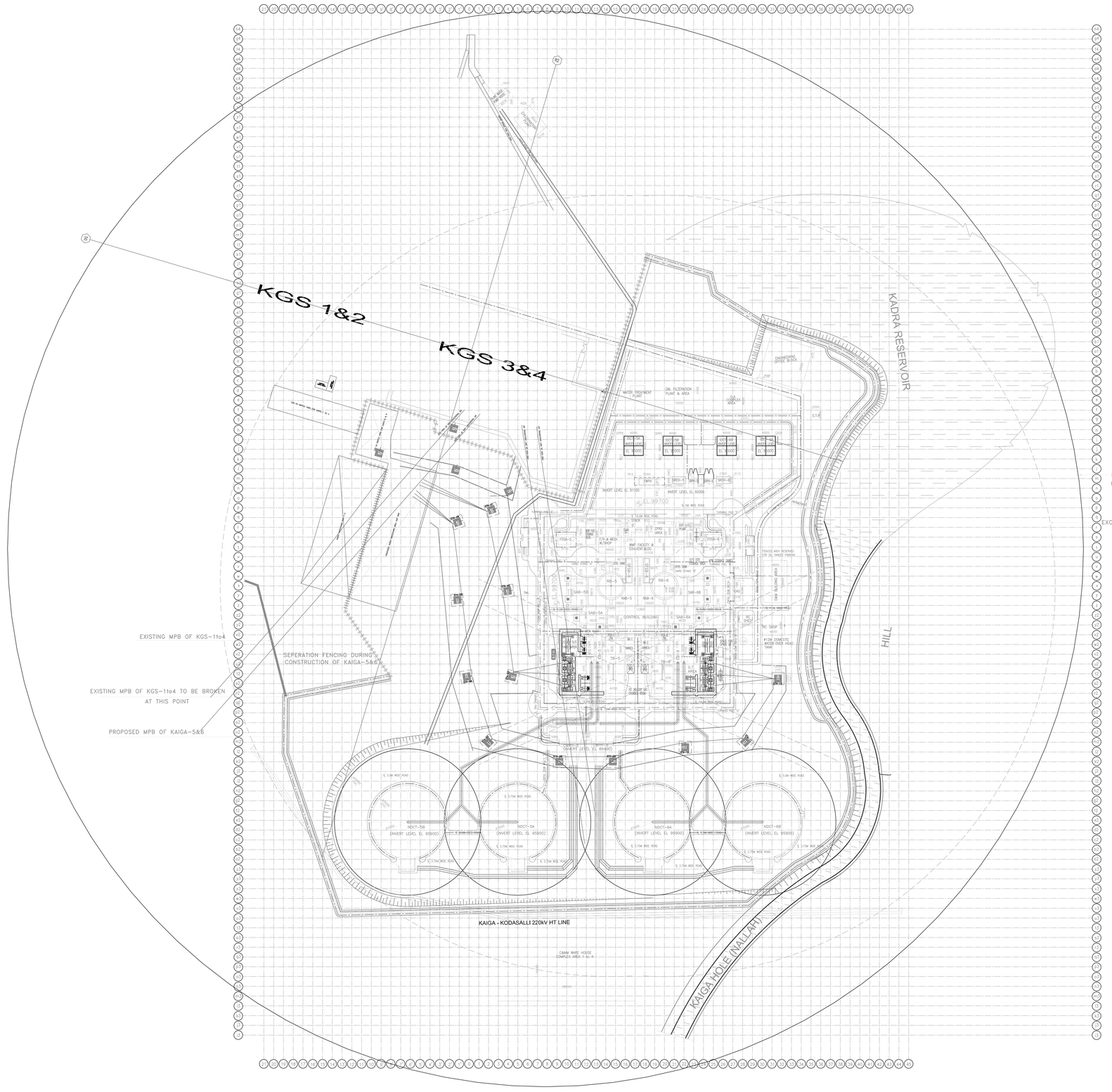
TOLERANCES ON LINEAR DIMENSIONS (IS:2102)

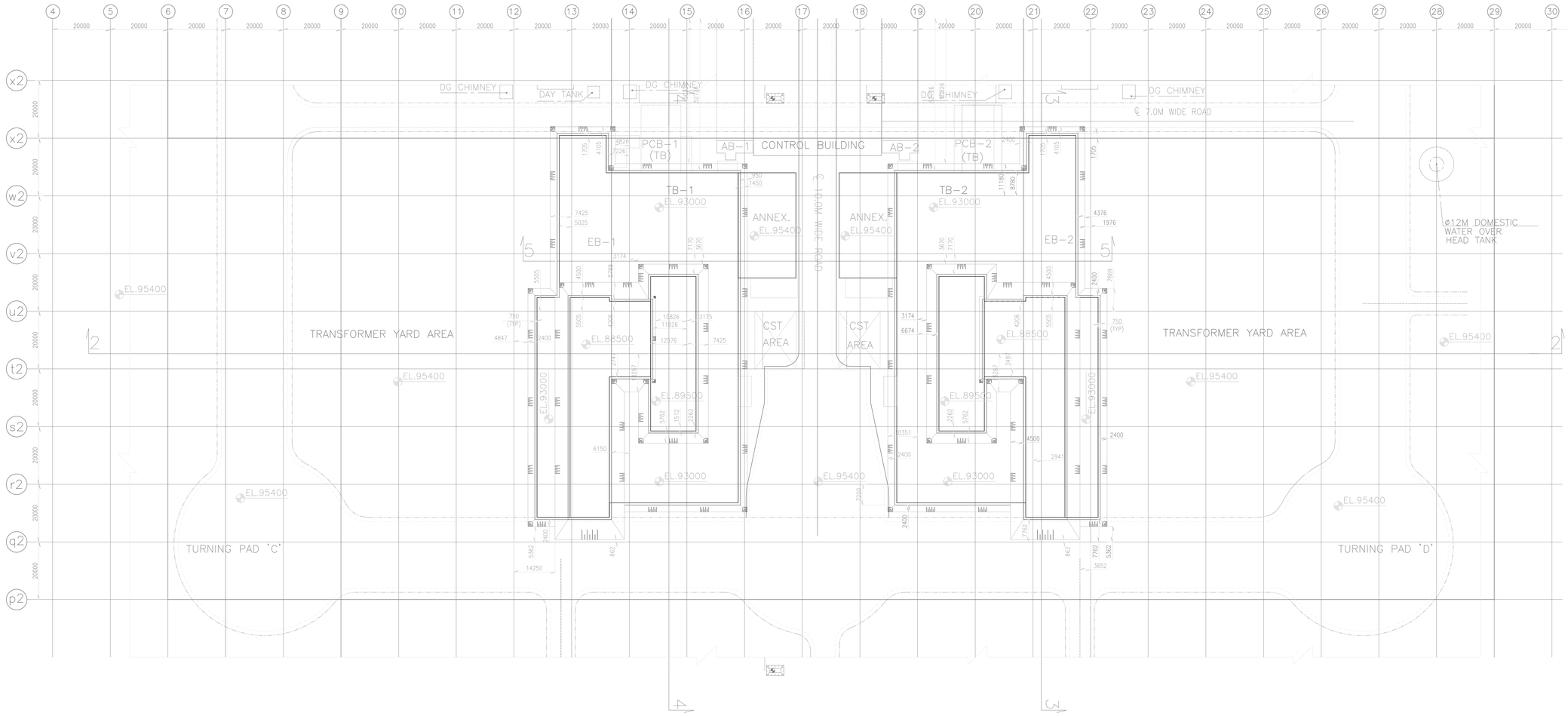
DIMENSIONS	TOL.	DIMENSIONS	TOL.
UPTO 6	± 0.1	315 – 1000	± 0.8
6 – 30	± 0.2	1000 – 2000	± 1.2
30 – 120	± 0.3	2000 – 4000	± 2.0
120 – 315	± 0.5	4000 – 8000	± 3.0

TOLERANCES ON LINEAR DIMENSIONS

SPECIFIED DIMENSIONS	TOLERANCE
XX	±
XX.X	±
XX.XX	±

TOLERANCES ON ANGULAR DIMENSIONS : ± 0° – 30'


KGS 1&2
KGS 3&4
KADRA RESERVOIR
HILL
EXISTING MPB OF KGS-1to4
SEPERATION FENCING DURING CONSTRUCTION OF KAIGA-5&6
EXISTING MPB OF KGS-1to4 TO BE BROKEN AT THIS POINT
PROPOSED MPB OF KAIGA-5&6
KAIGA - KODASALLI 220kV HT LINE
KAIGA HOLE (NALLAH)
PROPERTY FENCE (NTS)
(CHAIN LINK FENCING EXCEPT IN WATER BODY)
EXCLUSION ZONE BOUNDARY OF KAIGA-5&6 (NTS)
WATER TREATMENT PLANT
DM EXTENTION PLANT & AREA
ENGINEERING STORES BLOCK
CONTROL BUILDING
NDCT-5B (INVERT LEVEL EL 95900)
NDCT-5A (INVERT LEVEL EL 95900)
NDCT-6A (INVERT LEVEL EL 95900)
NDCT-6B (INVERT LEVEL EL 95900)
CWPH
SWPH
FWPH
SRPH
FOSA-5
FOSA-6
T/N W MCR W/SHOP
MMF FACILITY & CANTEEN BLDG.
TC SHOP
413M DOMESTIC WATER OVER HEAD TANK
CAMM WARE HOUSE COMPLEX AREA-1 to -4
SAB-5B
SAB-5A
SAB-6B
SAB-6A
RB-5
RB-6
RAD-5
RAD-6
TURBINE HALL
G.T. AREA
SWITCH YARD
OVS SUMP
OVS TANK
OVS PUMP
SUMP
SUMP PUMP
SUMP TANK
SRPH-5
SRPH-6
CWPH-5
CWPH-6
FWPH-5
FWPH-6
SWPH-5
SWPH-6
INVERT LEVEL EL 91700
INVERT LEVEL EL 92000
INVERT LEVEL EL 89400
EL 99700
EL 97700
EL 97000
EL 95000
EL 93000
EL 91000
EL 89000
E.S.W. MCC ROAD
E.S.W. MCC ROAD
E.S.W. MCC ROAD



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REFERENCE DRAWINGS	DRAWING No.	REFERENCE DRAWINGS	DRAWING No.	REFERENCE DRAWINGS	DRAWING No.

REV. No.	REV. LOCATION	DESCRIPTION	DR'N.	DES'D.	DES.CHK'D.	REV'D.	APP'D.

REVISIONS

SIGNATURE (NPCIL)

DO NOT SCALE THE DRAWING.

UNLESS OTHERWISE STATED :–
ALL DIMENSIONS ARE IN mm.
MACHINE ALL OVER.
SURFACE FINISH TO BE $\sqrt{3.2}$ OR BETTER.
REMOVE ALL BURRS.
REMOVE ALL EXTERNAL SHARP CORNERS
AND EDGES BY CHAMFERING TO $^{0\ .\ 15}_{0\ .\ 40}$ X 45°.
ROUND ALL INTERNAL CORNERS AND EDGES TO R $^{0\ .\ 15}_{0\ .\ 40}$.
TOLERANCES ON RADII AND CHAMFERS (IS : 2102)

RADII AND CHAMFERS	0.5–3	3–6	6–30
TOLERANCES	± 0.2	± 0.5	± 1.0

TOLERANCES ON LINEAR DIMENSIONS (IS:2102)

DIMENSIONS	TOL.	DIMENSIONS	TOL.
UPTO 6	± 0.1	315– 1000	± 0.8
6 – 30	± 0.2	1000– 2000	± 1.2
30 – 120	± 0.3	2000– 4000	± 2.0
120 – 315	± 0.5	4000– 8000	± 3.0

TOLERANCES ON LINEAR DIMENSIONS

SPECIFIED DIMENSIONS	TOLERANCE
XX	±
XX.X	±
XX.XX	±

TOLERANCES ON ANGULAR DIMENSIONS : ± 0° – 30'

REV. No.	DESCRIPTION	DATE	APP'D.

DRAWING ISSUED FOR

NUCLEAR POWER CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

TITLE :– KAIGA ATOMIC POWER PROJECT – 5&6

EXCAVATION PLAN

DES'D.	DR'N.	REV'D.
DES. CHK'D.	DRG. CHK'D.	APP'D.

PROJECT KAIGA–5&6

SCALE – 1:1

PROJECTION

DRG. No. KAIGA–5&6/16000/2003/SK

REV. No.

FILE NAME:

DRG. TO BE READ IN CONJUNCTION WITH DCN/FCN/ECN, IF ANY.

A0

DRG. No. KAIGA–5&6/16000/2003/SK

NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Government of India Enterprises)

PROCUREMENT SPECIFICATION NUMBER:

GHAVP- 1&2/40000/PROCUREMENT SPECIFICATION/ MS-1
GHAVP- 3&4/40000/PROCUREMENT SPECIFICATION/ MS-1
KAIGA- 5&6/40000/PROCUREMENT SPECIFICATION/ MS-1

PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND PACKAGE

SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES: ADDENDUM -1

Revision No	**R0**			
Date Of Issue (Month / Year)	**07/2019**			
Total No of Pages (Including Cover Sheet)	**7**			

Prepared By	**SUDHANSHU PANDEY, Sr. EE (Civil)**		**11/07/2019**
	VIJAY SINGH, Sr. EE (Civil)		**11/07/2019**
Checked By	**A.K.LAHARIA, SO/H (Civil)**		**11/07/2019**
Reviewed By	**N.M.RAO, CE (Civil)**		**11/07/2019**
Approved By	**ARVIND SHRIVASTAVA AD (Civil) & Head (Civil Engineering Group)**		**11/07/2019**
	(Name & Designation)	**(Signature)**	**(Date)**

REVISION CONTROL SHEET

PROCUREMENT SPECIFICATION NUMBER:

GHAVP- 1&2/40000/PROCUREMENT SPECIFICATION/ MS-1
GHAVP- 3&4/40000/PROCUREMENT SPECIFICATION/ MS-1
KAIGA- 5&6/40000/PROCUREMENT SPECIFICATION/ MS-1

FOR
TURBINE ISLAND
SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES: ADDENDUM - 1

REV. NO. / DATE	DESCRIPTION	PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY

Specific Technical requirements of Civil Works: Addendum -1

S. No.	Project	Clause No.	Existing Provision	Revised Provision
1.	GHAVP – 1&2	10.9.1	These specifications cover coating of reinforcement bars with fusion bonded epoxy coating (FBEC) to be provided as corrosion protection measure, in construction of Nuclear Power plant. This coating shall be used, wherever specified so in the drawings.	Fusion Bonded Epoxy Coated reinforcement bars not to be used.
2.	KAIGA – 5&6	10.9.1	These specifications cover coating of reinforcement bars with fusion bonded epoxy coating (FBEC) to be provided as corrosion protection measure, in construction of Nuclear Power plant. This coating shall be used, wherever specified so in the drawings.	Fusion Bonded Epoxy Coated reinforcement bars not to be used.
3.	GHAVP – 1&2	1.11	• Backfilling: A) Area Grading: i) Upto EL 98.70m: Using soil (at OMC) with 5% cement (by weight of dry soil) and compacting the same as per relevant specifications for Backfilling /ground improvement unless approved otherwise. PCC may be used, only if specifically approved by the engineer without financial implication.	• Backfilling: C) Area Grading: i) Upto EL 95.4m: Using soil (at OMC) with 5% cement (by weight of dry soil) and compacting the same as per relevant specifications for Backfilling /ground improvement unless approved otherwise. PCC may be used without financial implication. ii) Above EL 95.4m upto EL98.7m: Using compacted soil as per technical specification (as per clause no. 4). PCC may

			ii) Above EL 98.70m: Soil suitable for land escaping/ Soil Cement mix as approved by the Engineer. B) Within Foot Print of structure/ equipment Foundation: PCC shall be used, unless specifically approved by the Engineer. The properties of the back fill material used shall be suitably accounted in the design.	be used without financial implication. iii) Above EL 98.70m: Compacted Soil/Soil suitable for land escaping as required and as approved by the Engineer. D) Within Foot Print of structure/ equipment Foundation: Soil-cement shall be used, unless specifically approved by the Engineer. The properties of the back fill material used shall be suitably accounted in the design. PCC may be used without financial implication.
4.	GHAVP – 1&2	1.6.7	The construction of 10 m wide road between grid 17-18 within terminal point is excluded from the scope of the bidder. However the bidder shall fill the area up to subgrade i.e. EL 98.0m, with soil cement mix as per the specification. The typical cross section to be followed for the road is given in Sketch No. GHAVP 1&2/15600/5001/SK attached with the tender.	The construction of 10 m wide road between grid 17-18 within terminal point and Hard Stand "C" is excluded from the scope of this tender. However, the bidder shall fill the area up to EL 95.4m with soil cement mix as per detailed technical specifications. From EL 95.4m to EL97.4m, compacted soil shall be used as per technical specification (as per clause no. 4).
5.	GHAVP – 1&2	1.6.8	The Hard Stand "C" is excluded from the scope of this tender. However, the area below the Hard stand within terminal point shall be graded upto EL 98.00 with soil cement mix as per detailed technical specifications.	The Hard Stand "C" is excluded from the scope of this tender. However, the area below the Hard stand within terminal point shall be graded upto EL 95.4m with soil cement mix as per detailed technical specifications. From EL 95.4m to EL97.4m,

				compacted soil shall be used as per technical specification (as per clause no. 4).
6.	GHAVP – 1&2	1.11	Structure above Raft: Reinforced Cement Concrete (RCC), unless approved otherwise by the Purchaser. RCC slabs and roofs shall be constructed using Galvanized deck sheets as left in shuttering, unless specifically approved otherwise.	Structure above Raft: The roof of Turbine buildings shall be cast in situ RCC over Steel Deck Span Sheets. The roof of Turbine Buildings shall be laid over steel roof trusses and purlins. Bidder may please note the specific requirements towards removal of generator stator as given in clause 1.6.1 of section C-2-1. The use of Steel Deck Span Sheets for construction of RCC slabs other than roof is optional. Secondary steel beam may be permitted in specific cases subject to approval of Purchaser, if this meets all the structural and functional requirements including the fire rating.
7.	GHAVP – 1&2	2.5.1.2	Similarly dynamic analysis shall be performed using dynamic modulus of elasticity, $E_{dynamic}$ (using correction factor of G/G_{max} = 0.4, where Gmax corresponds to low strain shear modulus) under sustained load plus Earthquake loading to obtain dynamic springs as $Kx_{dynamic}$, $Ky_{dynamic}$ and $Kz_{dynamic}$.	$E_{dynamic}$ data for soil is enclosed herewith. (Annexure -1)
8.	KAIGA – 5&6	2.5	ANALYSIS AND DESIGN	Soil Structure Interaction shall be done using ABAQUS methodology as given in clause no. 2.5 of GHAVP-1&2 specification.

9.	KAIGA – 5&6	1.7.2	The bidder has to carry out at least following confirmatory geological tests for both the buildings independently, to demonstrate the suitability of geotechnical parameters considered, in his design within the area covered in the scope of the bidder unless approved otherwise by the Engineer. • minimum one bore hole of nx size (As required, but not lesser than 60m depth from founding level), • analyzing & arriving at safe bearing capacity using RMR & Unconfined compressive strength of core (having a minimum factor of safety of 10) approach. and a lesser of these 2 values shall be considered in the design in case of rock. • cyclic plate load tests under TG foundation area & • Geological mapping at the founding level of foundation & its side area, The bidder shall also carry out the ground improvement by consolidation grouting as per IS 6066 & conduct the water loss test as per IS 5529(Part 2), unless	Following confirmatory test shall be conducted (for each unit): 1. Field Tests: a) 1 Plate load test (for SBC and E value) at founding level b) 2-borehole upto 70m depth. • For Soil portion– SPT shall be carried out at every 3 m interval • For Rock portion– RQD, CR at every 3m interval or change in strata c) 1 Borehole upto 70m depth (for E value by Pressuremeter test) at every 5m interval or change in strata 2. Lab tests: a) Dry Density b) Specific Gravity c) UCS (Soaked) for rock portion at every 3m interval d) Triaxial shear Test (in soil portion for both drained & undrained condition) at every 3m interval. 3. SBC & E value to be used in analysis and design, shall verified based on confirmatory test 4. Geological mapping at the founding level of foundation & its side area, The bidder shall also carry out the ground improvement by consolidation grouting as per IS 6066 & conduct the water loss test as per IS 5529(Part 2), unless approved otherwise by the Engineer. All the above activities shall be executed as

			approved otherwise by the Engineer. All the above activities shall be executed as per the relevant technical specifications detailed in subsequent clauses of this tender.	per the relevant technical specifications detailed in subsequent clauses of this tender.
10.	GHAVP-1&2	2.3.1.2	The value of subgrade reaction for both static and dynamic analysis shall be worked out as per detailed soil structure analysis using ABAQUS or equivalent software. The detailed approach for the same is given in clause 2.4 below.	The value of subgrade reaction for both static and dynamic analysis shall be worked out as per detailed soil structure analysis using ABAQUS or equivalent software. The detailed approach for the same is given in clause 2.5 below.
11.	GHAVP-1&2	2.4.1.3	Using spring values calculated by above approach further structural analysis shall be carried out using any standard Finite Element software like NISA, ANSYS, ABAQUS, and SAP etc.	Clause 2.4.1.3 shall be read as clause 2.5.1.3.

ANNEXURE – I

MEAN					
Elevation of Bottom of layer from FGL	Depth (m) of Bottom of Layer from EGL	Depth (m) of Bottom of Layer from FGL	Poisson's ratio μ = (Vp2-2Vs2)/(2*(Vp2-Vs2))	Ed=2G(1+ν) kN/m2	Mean Unit weight (kN/m3)
100					
95	0	5			
93.6	1.4	6.4	0.38	7.30E+06	19.61
92.2	2.8	7.8	0.38	7.02E+06	19.61
90.8	4.2	9.2	0.38	6.79E+06	19.61
89.4	5.6	10.6	0.38	6.53E+06	19.61
87.9	7.1	12.1	0.38	6.34E+06	19.61
86.4	8.6	13.6	0.38	6.05E+06	19.61
84.9	10.1	15.1	0.38	5.88E+06	19.61
83.4	11.6	16.6	0.38	5.63E+06	19.61
81.9	13.1	18.1	0.33	2.56E+05	18.3
80.4	14.6	19.6	0.33	2.77E+05	18.47
79	16	21	0.32	3.17E+05	18.18
78	17	22	0.32	3.06E+05	18.04
76.5	18.5	23.5	0.32	2.96E+05	18.12
75	20	25	0.32	3.08E+05	18.33
73.5	21.5	26.5	0.32	3.22E+05	18.44
72	23	28	0.31	3.23E+05	18.27
70.5	24.5	29.5	0.32	3.14E+05	18.28
69	26	31	0.32	3.20E+05	18.47
67.5	27.5	32.5	0.32	3.42E+05	18.44
66	29	34	0.31	3.65E+05	18.56
64.5	30.5	35.5	0.32	4.12E+05	18.56
63	32	37	0.32	4.19E+05	18.45
61.5	33.5	38.5	0.32	3.71E+05	18.45
60	35	40	0.32	3.77E+05	18.42
58.5	36.5	41.5	0.30	3.70E+05	18.38
57	38	43	0.29	3.82E+05	18.21
55.5	39.5	44.5	0.30	3.95E+05	18.22
54	41	46	0.31	4.30E+05	18.19
52.5	42.5	47.5	0.31	4.43E+05	18.09
51	44	49	0.30	4.74E+05	18.27
49.5	45.5	50.5	0.30	4.83E+05	18.31
48	47	52	0.31	4.76E+05	18.35
46.5	48.5	53.5	0.31	4.82E+05	18.07
45	50	55	0.35	4.01E+05	17.79
43.5	51.5	56.5	0.34	4.76E+05	17.54
42	53	58	0.34	4.52E+05	17.59
40.5	54.5	59.5	0.33	4.59E+05	17.57
39	56	61	0.34	4.67E+05	17.95
37.5	57.5	62.5	0.34	5.04E+05	18.49
36	59	64	0.34	5.40E+05	18.85
34.5	60.5	65.5	0.35	5.50E+05	18.99
33	62	67	0.34	5.36E+05	19.06
31.5	63.5	68.5	0.33	5.84E+05	19.09
30	65	70	0.33	6.20E+05	19.03
28.5	66.5	71.5	0.34	5.27E+05	19.25
27	68	73	0.33	5.54E+05	19.36
25.5	69.5	74.5	0.34	5.38E+05	19.41
24	71	76	0.35	5.51E+05	19.29
22.5	72.5	77.5	0.35	5.57E+05	19.31
21	74	79	0.35	5.68E+05	19.31
19.5	75.5	80.5	0.36	5.27E+05	19.32
18	77	82	0.35	5.57E+05	19.37
16.5	78.5	83.5	0.34	5.60E+05	19.12
15	80	85	0.36	5.42E+05	19
13.5	81.5	86.5	0.36	5.43E+05	18.94
12	83	88	0.35	6.17E+05	19.06
10.5	84.5	89.5	0.35	6.03E+05	19.04
9	86	91	0.36	5.94E+05	19.03
7.5	87.5	92.5	0.35	6.00E+05	19.03
6	89	94	0.36	5.95E+05	18.73
4.5	90.5	95.5	0.36	5.59E+05	18.54
3	92	97	0.36	5.47E+05	18.44
1.5	93.5	98.5	0.37	5.64E+05	18.39
-2.84217E-14	95	100	0.37	5.94E+05	18.66

-1.5	96.5	101.5	0.36	6.52E+05	18.65
-3	98	103	0.37	6.34E+05	18.64
-4.5	99.5	104.5	0.37	6.45E+05	18.64
-6	101	106	0.38	6.20E+05	18.34
-7.5	102.5	107.5	0.37	6.32E+05	18.66
-9	104	109	0.38	6.16E+05	18.82
-10.5	105.5	110.5	0.38	6.49E+05	18.9
-12	107	112	0.38	6.75E+05	19.08
-13.5	108.5	113.5	0.38	7.38E+05	19.12
-15	110	115	0.37	1.16E+06	19.12
-19	114	119	0.36	1.13E+06	19.12
-23	118	123	0.36	1.14E+06	19.12
-27	122	127	0.36	1.17E+06	19.12
-31	126	131	0.36	1.18E+06	19.12
-35	130	135	0.36	1.20E+06	19.12
-39	134	139	0.36	1.35E+06	19.12
-43	138	143	0.36	1.45E+06	19.12
-47	142	147	0.36	1.49E+06	19.12
-51	146	151	0.36	1.53E+06	19.12
-55	150	155	0.36	1.54E+06	19.12
-59	154	159	0.36	1.55E+06	19.12
-63	158	163	0.36	1.57E+06	19.12
-67	162	167	0.36	1.60E+06	19.12
-71	166	171	0.36	1.63E+06	19.12
-75	170	175	0.36	1.66E+06	19.12
-79	174	179	0.36	1.71E+06	19.12
-83	178	183	0.37	1.75E+06	19.12
-87	182	187	0.37	1.77E+06	19.12
-91	186	191	0.37	1.79E+06	19.12
-95	190	195	0.37	1.82E+06	19.12
-99	194	199	0.37	1.84E+06	19.12
-103	198	203	0.37	1.86E+06	19.12
-107	202	207	0.37	1.88E+06	19.12
-113	208	213	0.37	1.92E+06	19.12
-119	214	219	0.37	1.96E+06	19.12
-125	220	225	0.36	1.99E+06	19.12
-135	Half Space		0.37	1.99E+06	19.12

UPPER BOUND					
Elevation of Bottom of layer from FGL	Depth (m) of Bottom of Layer from EGL	Depth (m) of Bottom of Layer from FGL	Poisson's ratio $\mu = (V_p^2-2V_s^2)/(2*(V_p^2-V_s^2))$	Ed=2G(1+ν) kN/m^2	Mean Unit weight (kN/m3)
100					
95	0	5			
93.6	1.4	6.4	0.38	1.49E+07	19.61
92.2	2.8	7.8	0.38	1.45E+07	19.61
90.8	4.2	9.2	0.38	1.41E+07	19.61
89.4	5.6	10.6	0.38	1.39E+07	19.61
87.9	7.1	12.1	0.38	1.37E+07	19.61
86.4	8.6	13.6	0.38	1.35E+07	19.61
84.9	10.1	15.1	0.38	1.31E+07	19.61
83.4	11.6	16.6	0.38	1.27E+07	19.61
81.9	13.1	18.1	0.33	8.08E+05	18.3
80.4	14.6	19.6	0.33	8.75E+05	18.47
79	16	21	0.32	1.04E+06	18.18
78	17	22	0.32	1.00E+06	18.04
76.5	18.5	23.5	0.32	9.72E+05	18.12
75	20	25	0.32	1.01E+06	18.33
73.5	21.5	26.5	0.32	1.06E+06	18.44
72	23	28	0.31	1.06E+06	18.27
70.5	24.5	29.5	0.32	1.03E+06	18.28
69	26	31	0.32	1.05E+06	18.47
67.5	27.5	32.5	0.32	1.11E+06	18.44
66	29	34	0.31	1.16E+06	18.56
64.5	30.5	35.5	0.32	1.29E+06	18.56
63	32	37	0.32	1.32E+06	18.45
61.5	33.5	38.5	0.32	1.10E+06	18.45
60	35	40	0.32	1.12E+06	18.42
58.5	36.5	41.5	0.30	1.11E+06	18.38
57	38	43	0.29	1.15E+06	18.21
55.5	39.5	44.5	0.30	1.18E+06	18.22
54	41	46	0.31	1.30E+06	18.19
52.5	42.5	47.5	0.31	1.34E+06	18.09
51	44	49	0.30	1.46E+06	18.27
49.5	45.5	50.5	0.30	1.48E+06	18.31
48	47	52	0.31	1.46E+06	18.35
46.5	48.5	53.5	0.31	1.44E+06	18.07
45	50	55	0.35	1.17E+06	17.79
43.5	51.5	56.5	0.34	1.52E+06	17.54
42	53	58	0.34	1.45E+06	17.59
40.5	54.5	59.5	0.33	1.46E+06	17.57
39	56	61	0.34	1.49E+06	17.95
37.5	57.5	62.5	0.34	1.59E+06	18.49
36	59	64	0.34	1.69E+06	18.85
34.5	60.5	65.5	0.35	1.72E+06	18.99
33	62	67	0.34	1.68E+06	19.06
31.5	63.5	68.5	0.33	1.83E+06	19.09
30	65	70	0.33	1.95E+06	19.03
28.5	66.5	71.5	0.34	1.55E+06	19.25
27	68	73	0.33	1.65E+06	19.36
25.5	69.5	74.5	0.34	1.60E+06	19.41
24	71	76	0.35	1.65E+06	19.29
22.5	72.5	77.5	0.35	1.66E+06	19.31
21	74	79	0.35	1.70E+06	19.31
19.5	75.5	80.5	0.36	1.58E+06	19.32
18	77	82	0.35	1.67E+06	19.37
16.5	78.5	83.5	0.34	1.68E+06	19.12
15	80	85	0.36	1.64E+06	19
13.5	81.5	86.5	0.36	1.63E+06	18.94
12	83	88	0.35	1.84E+06	19.06
10.5	84.5	89.5	0.35	1.80E+06	19.04
9	86	91	0.36	1.78E+06	19.03
7.5	87.5	92.5	0.35	1.78E+06	19.03
6	89	94	0.36	1.77E+06	18.73
4.5	90.5	95.5	0.36	1.66E+06	18.54
3	92	97	0.36	1.62E+06	18.44
1.5	93.5	98.5	0.37	1.66E+06	18.39
-2.84217E-14	95	100	0.37	1.74E+06	18.66

-1.5	96.5	101.5	0.36	1.90E+06	18.65
-3	98	103	0.37	1.84E+06	18.64
-4.5	99.5	104.5	0.37	1.87E+06	18.64
-6	101	106	0.38	1.79E+06	18.34
-7.5	102.5	107.5	0.37	1.82E+06	18.66
-9	104	109	0.38	1.76E+06	18.82
-10.5	105.5	110.5	0.38	1.86E+06	18.9
-12	107	112	0.38	1.91E+06	19.08
-13.5	108.5	113.5	0.38	2.07E+06	19.12
-15	110	115	0.37	2.75E+06	19.12
-19	114	119	0.36	3.05E+06	19.12
-23	118	123	0.36	3.08E+06	19.12
-27	122	127	0.36	3.15E+06	19.12
-31	126	131	0.36	3.19E+06	19.12
-35	130	135	0.36	3.22E+06	19.12
-39	134	139	0.36	3.31E+06	19.12
-43	138	143	0.36	3.54E+06	19.12
-47	142	147	0.36	3.60E+06	19.12
-51	146	151	0.36	3.66E+06	19.12
-55	150	155	0.36	3.74E+06	19.12
-59	154	159	0.36	3.82E+06	19.12
-63	158	163	0.36	3.87E+06	19.12
-67	162	167	0.36	3.93E+06	19.12
-71	166	171	0.36	3.98E+06	19.12
-75	170	175	0.36	4.03E+06	19.12
-79	174	179	0.36	4.12E+06	19.12
-83	178	183	0.37	4.20E+06	19.12
-87	182	187	0.37	4.24E+06	19.12
-91	186	191	0.37	4.29E+06	19.12
-95	190	195	0.37	4.33E+06	19.12
-99	194	199	0.37	4.38E+06	19.12
-103	198	203	0.37	4.42E+06	19.12
-107	202	207	0.37	4.46E+06	19.12
-113	208	213	0.37	4.54E+06	19.12
-119	214	219	0.37	4.61E+06	19.12
-125	220	225	0.36	4.68E+06	19.12
-135	Half Space		0.37	4.69E+06	19.12

LOWER BOUND					
Elevation of Bottom of layer from FGL	Depth (m) of Bottom of Layer from EGL	Depth (m) of Bottom of Layer from FGL	Poisson's ratio $\mu = (V_p^2-2V_s^2)/(2*(V_p^2-V_s^2))$	Ed=2G(1+v) kN/m^2	Mean Unit weight (kN/m3)
100					
95	0	5			
93.6	1.4	6.4	0.38	3.59E+06	19.61
92.2	2.8	7.8	0.38	3.41E+06	19.61
90.8	4.2	9.2	0.38	3.26E+06	19.61
89.4	5.6	10.6	0.38	3.12E+06	19.61
87.9	7.1	12.1	0.38	2.96E+06	19.61
86.4	8.6	13.6	0.38	2.78E+06	19.61
84.9	10.1	15.1	0.38	2.69E+06	19.61
83.4	11.6	16.6	0.38	2.53E+06	19.61
81.9	13.1	18.1	0.33	8.41E+04	18.3
80.4	14.6	19.6	0.33	8.86E+04	18.47
79	16	21	0.32	8.37E+04	18.18
78	17	22	0.32	7.95E+04	18.04
76.5	18.5	23.5	0.32	7.64E+04	18.12
75	20	25	0.32	7.82E+04	18.33
73.5	21.5	26.5	0.32	8.25E+04	18.44
72	23	28	0.31	8.25E+04	18.27
70.5	24.5	29.5	0.32	8.05E+04	18.28
69	26	31	0.32	8.27E+04	18.47
67.5	27.5	32.5	0.32	8.76E+04	18.44
66	29	34	0.31	9.60E+04	18.56
64.5	30.5	35.5	0.32	1.10E+05	18.56
63	32	37	0.32	1.11E+05	18.45
61.5	33.5	38.5	0.32	1.19E+05	18.45
60	35	40	0.32	1.22E+05	18.42
58.5	36.5	41.5	0.30	1.21E+05	18.38
57	38	43	0.29	1.26E+05	18.21
55.5	39.5	44.5	0.30	1.28E+05	18.22
54	41	46	0.31	1.38E+05	18.19
52.5	42.5	47.5	0.31	1.44E+05	18.09
51	44	49	0.30	1.55E+05	18.27
49.5	45.5	50.5	0.30	1.58E+05	18.31
48	47	52	0.31	1.56E+05	18.35
46.5	48.5	53.5	0.31	1.58E+05	18.07
45	50	55	0.35	1.33E+05	17.79
43.5	51.5	56.5	0.34	1.27E+05	17.54
42	53	58	0.34	1.21E+05	17.59
40.5	54.5	59.5	0.33	1.22E+05	17.57
39	56	61	0.34	1.25E+05	17.95
37.5	57.5	62.5	0.34	1.34E+05	18.49
36	59	64	0.34	1.45E+05	18.85
34.5	60.5	65.5	0.35	1.48E+05	18.99
33	62	67	0.34	1.43E+05	19.06
31.5	63.5	68.5	0.33	1.57E+05	19.09
30	65	70	0.33	1.64E+05	19.03
28.5	66.5	71.5	0.34	1.70E+05	19.25
27	68	73	0.33	1.78E+05	19.36
25.5	69.5	74.5	0.34	1.72E+05	19.41
24	71	76	0.35	1.78E+05	19.29
22.5	72.5	77.5	0.35	1.78E+05	19.31
21	74	79	0.35	1.82E+05	19.31
19.5	75.5	80.5	0.36	1.69E+05	19.32
18	77	82	0.35	1.81E+05	19.37
16.5	78.5	83.5	0.34	1.81E+05	19.12
15	80	85	0.36	1.76E+05	19
13.5	81.5	86.5	0.36	1.76E+05	18.94
12	83	88	0.35	2.01E+05	19.06
10.5	84.5	89.5	0.35	1.97E+05	19.04
9	86	91	0.36	1.96E+05	19.03
7.5	87.5	92.5	0.35	1.98E+05	19.03
6	89	94	0.36	1.97E+05	18.73
4.5	90.5	95.5	0.36	1.85E+05	18.54
3	92	97	0.36	1.83E+05	18.44
1.5	93.5	98.5	0.37	1.89E+05	18.39
-2.84217E-14	95	100	0.37	2.00E+05	18.66
-1.5	96.5	101.5	0.36	2.15E+05	18.65
-3	98	103	0.37	2.10E+05	18.64

-4.5	99.5	104.5	0.37	2.15E+05	18.64
-6	101	106	0.38	2.08E+05	18.34
-7.5	102.5	107.5	0.37	2.11E+05	18.66
-9	104	109	0.38	2.05E+05	18.82
-10.5	105.5	110.5	0.38	2.18E+05	18.9
-12	107	112	0.38	2.27E+05	19.08
-13.5	108.5	113.5	0.38	2.48E+05	19.12
-15	110	115	0.37	3.99E+05	19.12
-19	114	119	0.36	3.90E+05	19.12
-23	118	123	0.36	3.95E+05	19.12
-27	122	127	0.36	4.04E+05	19.12
-31	126	131	0.36	4.10E+05	19.12
-35	130	135	0.36	4.16E+05	19.12
-39	134	139	0.36	4.31E+05	19.12
-43	138	143	0.36	5.01E+05	19.12
-47	142	147	0.36	5.27E+05	19.12
-51	146	151	0.36	5.48E+05	19.12
-55	150	155	0.36	5.48E+05	19.12
-59	154	159	0.36	5.34E+05	19.12
-63	158	163	0.36	5.38E+05	19.12
-67	162	167	0.36	5.62E+05	19.12
-71	166	171	0.36	5.72E+05	19.12
-75	170	175	0.36	5.83E+05	19.12
-79	174	179	0.36	6.26E+05	19.12
-83	178	183	0.37	6.56E+05	19.12
-87	182	187	0.37	6.60E+05	19.12
-91	186	191	0.37	6.67E+05	19.12
-95	190	195	0.37	6.83E+05	19.12
-99	194	199	0.37	6.94E+05	19.12
-103	198	203	0.37	6.98E+05	19.12
-107	202	207	0.37	7.06E+05	19.12
-113	208	213	0.37	7.25E+05	19.12
-119	214	219	0.37	7.45E+05	19.12
-125	220	225	0.36	7.65E+05	19.12
-135	Half Space		0.37	7.66E+05	19.12

NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Government of India Enterprises)

PROCUREMENT SPECIFICATION NUMBER:

KAIGA- 5&6/40000/PROCUREMENT SPECIFICATION/ MS-1

PROCUREMENT SPECIFICATION
FOR
TURBINE ISLAND PACKAGE

SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES: ADDENDUM -2

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	(Name & Designation)	(Signature)	(Date)

REVISION CONTROL SHEET

PROCUREMENT SPECIFICATION NUMBER:

KAIGA- 5&6/40000/PROCUREMENT SPECIFICATION/ MS-1

PROCUREMENT SPECIFICATION FOR TURBINE ISLAND SECTION C -2-1: SPECIFIC TECHNICAL REQUIREMENTS OF CIVIL STRUCTURES: ADDENDUM - 2

REV. NO. / DATE	DESCRIPTION	PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY
1	Geotechnical/geophysical information included. Compensation provisions modified in line with the discussions and requirements of procurement directorate.	Sudhanshu Pandey 28/08/19 V.S 28/08/19	28/8/19	28/8/19	29/08/19

Specific Technical requirements of Civil Works: Addendum -2

S. No.	Project	Clause No.	Existing Provision	Revised Provision
1.	KAIGA 5-6	1.7.2. (a)	The excavation of site will be carried out within the terminal points of this package by the Purchaser as indicated in the drawing no KAIGA 5&6/16000/2003 /SK. However, additional excavation, if any required from functional reasons due to system requirements or due to geotechnical reasons, shall be carried out by the contractor at his own cost. Wherever, the founding levels are lower than the levels specified in above drawing the ground shall be lowered by bidder using appropriate cutting tool like, rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. The over excavated / damaged ground, if any, shall be made good by the bidder at his own cost.	i) The excavation of site will be carried out within the terminal points of this package by the Purchaser as indicated in the drawing no KAIGA 5&6/16000/2003 /SK. However, additional excavation below EL 87.00m, if any required from functional reasons due to system requirements shall be carried out by the contractor at his own cost. ii) Bidder is requested to study the wide variation in the strata captured in all 16 bore holes while finalization of structural arrangement. iii) The Raft foundation of the structures other than Transformer Yard (i.e. foundation for equipment like SUTs, UTs, GTs, Rail, BOP and fire walls etc.) shall be laid at EL 87.00m. In case Piles are required below raft foundation at EL 87.00M, same shall also be provided by the Bidder without any extra cost to NPCIL. The foundations of equipment in transformer yard (like SUTs, UTs, GTs, Rail Yard) and other structures like BOP etc. shall be Raft or Raft with Pile and shall be provided at appropriate level, without any extra cost to the Purchaser. In case of Raft foundation for Equipment and structures of Transformer Yard, the safe allowable bearing pressure at founding level shall be established by the bidder by conducting plate load test (if founding on soil) or by

			Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure. Back filling of areas, wherever required, shall be done using suitable backfill material as decided by the Engineer, and is included in the scope of this tender. The same shall be done by the bidder at his own cost. The area under the structures shall be raised, by filling PCC only unless approved otherwise by the Engineer The bidder has to carry out at least following confirmatory geological tests for both the buildings independently, to demonstrate the suitability of geotechnical parameters considered, in his design within the area covered in the scope of the bidder unless approved otherwise by the Engineer. ▪ minimum one bore hole of nx size (As required, but not lesser than 60m depth from	UCS & RMR (if founding on rock), at no extra cost to Purchaser. In case of pile foundation relevant qualification test shall be performed as per specifications by the bidder at no extra cost to Purchaser. iv) Bidder shall use appropriate excavation equipment like mechanical excavator, rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. v) Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure. vi) Back filling of areas, wherever required, above founding level shall be done by the bidder, using suitable backfill material as approved by the Engineer at his own cost, and is included in the scope of this tender. The area below the foundation of structures shall be raised, by filling PCC only, unless approved otherwise by the Engineer. vii) The bidder has to carry out at least following confirmatory

			founding level), ▪ analyzing & arriving at safe bearing capacity using RMR & Unconfined compressive strength of core (having a minimum factor of safety of 10) approach. and a lesser of these 2 values shall be considered in the design in case of rock. ▪ cyclic plate load tests under TG foundation area & ▪ Geological mapping at the founding level of foundation & its side area, The bidder shall also carry out the ground improvement by consolidation grouting as per IS 6066 & conduct the water loss test as per IS 5529(Part 2), unless approved otherwise by the Engineer. All the above activities shall be executed as per the relevant technical specifications detailed in subsequent clauses of this tender.	geological tests for both the buildings independently at his own cost, to demonstrate the suitability of geotechnical parameters considered, in his design within the area covered in the scope of the bidder unless approved otherwise by the Engineer. Following confirmatory test shall be conducted (for each unit): 1. Field Tests: a) 1 Plate load test (for SBC and E value) at founding level b) 2-borehole upto 70m depth. • For Soil portion– SPT shall be carried out at every 3 m interval • For Rock portion– RQD, CR at every 3m interval or change in strata c) 1 Borehole upto 70m depth (for E value by Pressuremeter test) at every 5m interval or change in strata 2. Lab tests: a) Dry Density b) Specific Gravity c) UCS (Soaked) for rock portion at every 3m interval d) Triaxial shear Test (in soil portion for both drained & undrained condition) at every 3m interval. 3. SBC & E value to be used in analysis and design, shall verified based on confirmatory test 4. Geological mapping at the founding level of foundation & its side area, viii) The bidder shall also carry out the ground improvement by consolidation grouting as per IS

				6066 & conduct the water loss test as per IS 5529(Part 2), unless approved otherwise by the Engineer. All the above activities shall be executed as per the relevant technical specifications detailed in subsequent clauses of this tender. **ix) Bidder shall be suitably compensated for extra excavation & backfilling, *in the area other than Transformer yard,* if required, due to non-availability of competent rock , at EL 87.00m and bidder needs to go for deeper excavation upto competent rock. In such case, the Bidder shall remove the soil / weathered rock upto competent strata and backfill the same with PCC (M15 Grade) upto EL 87.00M. In such case, the compensation shall be made in the following manner. However, no such compensation will be made for the transformer yard area.** A) **Compensation for Excavation**: The Bidder shall excavate the area upto EL 87.00M from the levels indicated in Drawing No. KAIGA-5&6/16000/2003/SK at his own cost. However, the bidder will be compensated for excavation (in soil and weathered rock) below EL 87.00M, if required due to non-availability of competent rock, at a rate finalized as per provisions of contract. **However, no compensation will be made towards dewatering (including for the portion below EL 87.00m) and is deemed to be**

				included in Lum-Sum Price quoted for the works. B) **Compensation for Backfilling**: Bidder shall be suitably compensated for backfilling with PCC, only upto EL 87.00m, for the area which is required to be backfilled due to non-availability of competent rock at a rate finalized as per provisions of contract . No extra payment shall be made for the backfilling above EL 87.00M and it is deemed to inclusive in Lum-Sum Price quoted by the contractor. No payment will be made for the shuttering used for PCC work mentioned above.
2.		2.3.1.1	The safe bearing capacity at founding level of any structure shall be computed based on standard codal approach/ practices considering the geotechnical parameters of the influence zone, based on dimension of structure and maximum intensity of pressure. For finalization of influence zone, the foundation profile up to a depth, where net increase in vertical pressure becomes less than 10% of the initial overburden pressure from founding level of the structure shall be considered in the analysis.	Following foundation parameters shall be followed in the design: A) For the structures (other than Transformer Yard) i.e Turbine Building, Turbine Generator, Electrical Bay Building, Annex Building, Pipe & Cable Bridge and Access Bridge etc., bidder shall consider following foundation design parameters as bid basis:

Founding Level	EL 87000
Net Safe/Allowable bearing pressure SBC (Ton/m^2)	150
Static modulus of Elasticity, E (kg/cm^2)	$9.84x10^3$ – $9.82x10^5$
Static shear modulus, G (kg/cm^2)	$4.33x10^3$ – $4.02x10^5$

			The geotechnical parameters shall be evaluated based on bore hole data obtained on ground and required field test. The foundation of all structures and major equipment of transformer yard (SUT, UT, GT etc.) & oil separation pit, CCW Inlet & hot water tunnel, PCB & Electrical bay, Turbine Building and Turbo-generator etc. shall be taken from competent rock or supported on pile unless specifically approved otherwise by the engineer and as approved by the engineer. All other tunnel / trenches may be engineered & founded on PCC / fillcrete, unless approved otherwise and as approved by the Engineer.	<table><tr><td>Shear Wave Velocity, V (m/s)</td><td>1800 to 2500</td></tr><tr><td>Poisson's ratio, μ</td><td>0.2</td></tr></table> In case based on confirmatory geotechnical investigations, different parameters are required to be followed than those specified above, the bidder shall be suitably compensated for same. B) The foundation of transformer yard structures (SUT, UT, GT etc.) & oil separation pit, CCW Inlet & hot water tunnel shall be taken on Raft foundation from competent rock or Raft supported on pile. In case of Raft foundation for Equipment and structures of Transformer Yard, the safe allowable bearing pressure at founding level shall be established by the bidder by conducting plate load test (if founding on soil) or by UCS & RMR (if founding on rock), at no extra cost to Purchaser. In case of pile foundation, relevant qualification tests shall be performed and necessary geotechnical parameters, if required, shall be obtained by the bidder at no extra cost to Purchaser as per technical specifications. Bidder is requested to study the relevant borehole data of Transformer Yard and plan the foundation accordingly. All other tunnel / trenches may be engineered & founded on PCC / fillcrete, unless approved otherwise and as approved by the Engineer.
3.		3.1	The excavation of site will be carried out within the	The excavation of site will be carried out within the terminal points of this

			terminal points of this package by the Purchaser as indicated in the drawing no KAIGA 5&6/16000/2003 /SK. However, additional excavation, if any required from functional reasons due to system requirements or due to geotechnical reasons, shall be carried out by the contractor at his own cost. Wherever, the founding levels are lower than the levels specified in above drawing the ground shall be lowered by bidder using appropriate cutting tool like , rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. The over excavated / damaged improved ground, if any, shall be made good by the bidder at his own cost. Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder	package by the Purchaser as indicated in the drawing no KAIGA 5&6/16000/2003 /SK. The bidder shall excavate the area other than Transformer yard area upto EL 87.00M at his own cost. Additional excavation below EL 87.0M , wherever required, due to non- availability of rock shall be carried out by the bidder and he will be suitably compensated for same as per provisions of contract. Wherever, the founding levels are required to be lowered , the excavation shall be done using appropriate cutting tool like , rock breaker, chisel etc. which does not disturb and damage the adjoining structure and also do not have any adverse effect on the existing works being executed by other contractors in adjoining areas. The excavation using controlled blasting may be resorted in specific cases with prior approval of Engineer. Schedule of the additional excavation and backfilling shall be finalized in consultation with PURCHASER. Bidder must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure. Contractor shall make necessary arrangement for Dewatering alongwith standby arrangement at his own cost. The contractor has also to make necessary arrangements for side protection to avoid any slippage of rock/ soil etc. at his own cost. No extra payment will be made to remove any of slipped rock/earth etc. in the excavated area. The contractor is also requested to visit the site prior to

			must schedule his excavation and other activities considering the status of construction & schedule of construction of adjoining structure. Contractor shall make necessary arrangement for Dewatering alongwith stand by arrangement at his own cost. The contractor has also to make necessary arrangements for side protection to avoid any slippage of rock/ soil etc. at his own cost. No extra payment will be made to remove any of slipped rock/earth etc in the excavated area. The contractor is also requested to visit the site prior to quoting & satisfy himself with the actual site conditions. In case further excavation is required, the same shall be carried out as per following specifications. A) This section covers all the excavation works to be performed under this contract which shall consist of clearing of site and excavation of all existing material of whatever nature, to the lines and grades shown on the construction drawing or as otherwise	quoting & satisfy himself with the actual site conditions. In case further excavation is required, the same shall be carried out as per following specifications. A) This section covers all the excavation works to be performed under this contract which shall consist of clearing of site and excavation of all existing material of whatever nature, to the lines and grades shown on the construction drawing or as otherwise directed by the engineer. The work shall also include drilling and blasting, loading, hauling and disposal of materials in designated spoil, stockpile areas or directly as construction materials. B) The contractor shall also be responsible for excavation which is not specifically required for the construction of permanent structures, but incidental to the installation of temporary facilities such as site roads, approach ramps etc. C) Slope protection and stabilization measures, which may be needed in conjunction with surface excavation work, shall be carried out as defined in other sections of these specifications. D) The approval given by the Engineer during the course of execution, to the contractor's methods and equipment shall not relieve the contractor of his full responsibility for the proper and safe execution of excavations, or of liability for

			directed by the engineer. The work shall also include drilling and blasting, loading, hauling and disposal of materials in designated spoil, stockpile areas or directly as construction materials. B) The contractor shall also be responsible for excavation which is not specifically required for the construction of permanent structures, but incidental to the installation of temporary facilities such as site roads, approach ramps etc. C) Slope protection and stabilization measures, which may be needed in conjunction with surface excavation work, shall be carried out as defined in other sections of these specifications. D) The approval given by the Engineer during the course of execution, to the contractor's methods and equipment shall not relieve the contractor of his full	injuries to, or death of persons, or any other obligations under this contract. It shall also not relieve his responsibilities for the accuracy or adequacy of the plan for obtaining the desired results in the stipulated time schedule.

			responsibility for the proper and safe execution of excavations, or of liability for injuries to, or death of persons, or any other obligations under this contract. It shall also not relieve his responsibilities for the accuracy or adequacy of the plan for obtaining the desired results in the stipulated time schedule.	
4	KAIGA 5-6	2.1.1	Seven Boreholes BH103, RBH-104, RBH-109, BH-110, RBH-111, BH-115 and BH- 116 covers Turbine Building-5. Seven Boreholes BH105, RBH-112, BH-113, BH-106, RBH-114, BH-117 and RBH- 118 exists covers Turbine Building-6. Boreholes RBH-107 & RBH -108 covers Transformer Yard of both the units. The representative borehole data BH-110 & BH-113 are attached as Annexure-1 for guidance. The soil/ rock samples from boreholes will be tested & relevant data will be provided to bidder subsequently. Subsurface profile at Turbine building -5 & 6 areas generally consists	Borehole data for all the 16 boreholes were shared on 3rd June 2019 with the bidders in response to the query raised by M/s L&T. The existing ground level of bore hole no 108,110, & 113 is modified. These revised borehole are attached in Annexure – 1.

			of top soil followed by laterite, boulders/sand and rock as indicated in representative borehole data BH-110 & BH-113.	

Annexure – 1

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Project: Geotechnical Investigation of Kaiga 5&6.

Format No.: SFE/KAIGAS&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No: 108

Sheet: 1 of 6

Location: GT-AREA-6 | Co-ordinates: 24.2557N, 12.5509N, X=440403.0289, Y=1477986.8666

Feature:

Angle with vertical: — | UTM Co-ordinates:

Total depth: 30.50MTR | Collar Elevation:

Existing Ground Elevation: 98.574, 94.10 (B2 mean)

Type (s) of core barrel: Double Tube. | Started: 10/04/2019 | Completed: 27/05/2019

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Fracture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
0.00									Black humus soil						NX	Yes							
1.90									Brownish Fine Grained sand			Diamond Bit			NX	Yes							15 30 45 60 N 6 7 9 10 16
2.10									Brownish Fine to medium Grained sand with soft Clay						NX	Yes							
4.50															NX	Yes							15 30 45 60 N 6 9 10 11 19
5.70															NX	Yes							
7.00															NX	Yes							15 30 45 60 N 11 12 13 14 25
8.10															NX	Yes							
10.00																							

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SIGNATURE	Logged By (Geologist)	Checked By (QA)	Civil	QA
	(Mohd Aasaq Khan)	(Nitesh D Shinde)	(CN. Mohan Sole)	Litholog and observed log Nirmal Das

Dr. Dhanajit Das (Nirmal) Total 6 pages

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Project:

Format No. : SFE/KAIGAS&6/BD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 108

Sheet : 2 of 6

Location : | Co-ordinates | Feature :

Angle with vertical : | UTM Co-ordinates: | Existing Ground Elevation: 94.00 m

Total depth : | Collar Elevation:

Type (s) of core barrel : | Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 35 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
10.00				4, 10																			
11.50				13, 24, 25, 25, 25

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Format No. : SFE/KAIGAS&G/RO/01

Project:

Date:

Job No:

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Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 108

Sheet : 3 of 6

Location :

Co-ordinates

Feature :

Angle with vertical :

UTM Co-ordinates:

Total depth :

Collar Elevation:

Existing Ground Elevation: 94.00

Type (s) of core barrel :

Started :

Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
14.50																							
16.00				—	—	33,34,SP,36,37,38 SP,35	SP		Shattered ↓		46,66%	Diamond BIT	Nil	NX	Nil							
17.50				—	—	44,45	SP		Moderately Jointed,		90,66%		90,66%	NX	Nil			Partial					
18.00				—	—	39,42,43			Highly fractured		86,66%		75,33%	NX	Nil								
				52,SP					Dark Greenish, Quartz chlorite schist.														
				49,SP,51,55,56,57,SP					Silicification along the fracture zone)														
				46,																			
				47,48,53,SP																			

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Format No. : SFE/TANGABEA/RD/01

Project:

Date: | Created By: | Created on:

Job No: | Hole No : 108

GEOLOGICAL LOG OF BORE HOLE

Sheet : 4 of 6

Location : | Co-ordinates | Feature :

Angle with vertical : | UTM Co-ordinates: | Existing Ground Elevation: 94.00

Total depth : | Collar Elevation: | Completed:

Type (s) of core barrel : | Started :

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
19.00																							
20.50					60%	26%	6%	6%	SP 68 SS 59 Fo	Moderately Jointed, Rough Planar Joint Surface (Angle 60°)	88%	—	—	NX	NX	—	—	—	—	—	—	
22.00					73	7%	7%	7%	SP 80 SS 77 Fo	Moderately Jointed, fractured, Rough Planar Joint Surface (Angle 60°)	95.33%	Diamond Bit	76.66%	NX	NX	—	—	—	—	—	—	
23.50					SP 80	81			SS 77 Fo	Dark Greenish Grey, Moderately Jointed, Rough Planar Joint Surface (Angle 60°)	90%	Diamond Bit	85.33%	NX	NX	—	—	—	—	—	—	

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Project:

Date:

Job No:

Created By:

Format No.: SFE/LAN/66/66/RD/01

GEOLOGICAL LOG OF BORE HOLE

Created on:

Location :

Co-ordinates

Hole No : 10R

Sheet : 5 of 6

Angle with vertical :

Feature :

Total depth :

UTM Co-ordinates:

Type (s) of core barrel :

Collar Elevation:

Existing Ground Elevation: 94.00

Started :

Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
23.50																							
25.00					83.84.87		82.86	85.88.89	Fractured, moderately weathered, slightly rough surface	Angle 70°			88.66%	2	NX	NX	Nil						
26.50					92.95.96			90.91.93.94.97	Fractured, moderately weathered, slightly rough surface			Diamond BIT 92%	93.33%	2	NX	NX	Nil	Partial					
28.00					100			98.99.101	Fractured, moderately weathered, slightly rough surface				94.66%	2	NX	NX	Nil						

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Format No.: SFE/KAIGA5&6/RD/01

Date:

Job No:

Created By:

Created on:

GEOLOGICAL LOG OF BORE HOLE

Location: GT-AREA-6 Co-ordinates: 24°25'51.42"-15'M

Hole No: 108

Sheet: 6 of 6

Angle with vertical:

Co-ordinates: X=440203.0289 Y=1642[illegible]2666

Feature:

Total depth: 30.50MTR.

UTM Co-ordinates:

Collar Elevation:

Existing Ground Elevation: 98.574 94.00 msl

Type (s) of core barrel: Double Tube

Started:

Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0	20	40	60	80	100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete.	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
28.00							102,103,104		Dark Green ish, moderately fractured						85.33%		Diamond BIT	85.33%		NX	NX							
29.50									moderately weathered, Meta Gabbro														Partial Loss					
30.50						SP	105	106	Dark Green ish, Moderately weathered, Meta Gabbro						79%			75%		NX	NX							
		Borehole Terminated at Depth 30.50MTR.																										

SIGNATURE	Sohams: Logged By (Geologist)	Sohams: Checked By (QA)	NPCIL: Civil	NPCIL: QA
	(Mohd Aasif Khan)	(Sailesh Dighade)	CN. Mohan Rao	Dr. Dhanjit Das (NPCIL)

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Rec. 27/11/18

water Table - 2.90 m

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Project: Carrying out Geo-technical and Geo-Physical investigations for Kaiga 5&6, Kaiga Site, PO Kaiga, Karwar, Uttara Kannada Dist. Karnataka state

Format No. SFE/KAIGAS&6/RD/01

Date: —

Job No: — | Created By: — | Created on: —

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110

Sheet : 1 of 10

Location : TB-5 | Co-ordinates 15+4.5M 70U2 | Feature : Gallery

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 96.356 ~~95.172~~ 96.356

Total depth : 56.10 MTR. | Type (s) of core barrel : Double Tube

Started : 3/5/2018 | Completed: 8/7/2018 | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
0.00									Red-sty muram						NX	NX							
1.50																							15 30 45 N 10 15 26 41
1.95									Boulders in Soil									Partial					
4.30															NX	NX							
4.86														Diamond Bit									15 30 45 N 11 17 23 40
7.50															NX	NX							
9.00				—	—	23	—	—	SPT 1.5P. Highly weathered Light Grey Fractured Granite.		5 — 62 — —	NX	16%		NX	NX							

Sohams		NPCIL	
Logged By (Geologist)	Checked By (QA)	Civil	QA
SIGNATURE	Badra	Rao	mohan	Lithology and structural log verified

S.F.E.

(N. mohan)

total 10 pages Dr. Dhansi Das NIRM Total 10 pages

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Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110

Sheet : 2 of 10

Location : TB-5 | Co-ordinates 15 FG 559 70 02 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 96.356

Total depth : 56.10 MTR | Type (s) of core barrel : Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
9.00																							
10.50				1	1	4,5,	10,	SP,6,7,8,9,	Highly Schist,		1 1 92% 1 1	NX	53.33%		NX	Nil							
12.50				1	1	13,15,	14,	11, SP,16	Highly fractured, Chlorite weathered		1 1 58% 1 1	NX	29.5		NX	Nil		Partial					
13.80				1	1	14,	18,19,	SP,20.			1 1 78% 1 1	NX	78%		NX	Nil							
14.00				1	1	1	21,	22,23,24.	Greyish		1 1 97% 1 1	NX	94%		NX	Nil							

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SIGNATURE			

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Format No. SFE/KAIGA5&6/RO/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : BH-10

Sheet : 3 of 10

Location : TB 5 | Co-ordinates (5+4, 5TH TOWER) | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: ~~95.17~~ 96.356

Total depth : 56.10 MTR. | Type (s) of core barrel : Double Tube

Started : | Completed: | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery (0 20 40 60 80 100)	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
14.00																							
15.00						5P.	25, 27.	26.	Greyish, slightly weathered Charnockite Gneiss.		23%	NX	15%		NX	NX							
17.50						28, 5P	29, 31, 33	30, 32	Light Greyish, Moderately weathered, slightly fractured,		88%	NX	86.4%		NX	NX		→ Partial					
18.50				37, 41	38, 38, 42,	34, 35, 39, 40, 43		5P, 5P	To Greyish White,		82%	NX	59%		NX	NX							
20.00				46, 47,	48, 50, 52, 53	54, 51		45, 49, 54.			83%	NX	73.33%		NX	NX							

	Sohams		NPCIL	
SIGNATURE	Logged By (Geologist)	Checked By (QA)	Civil	QA
Mahendra Meshram	Rachu	Rao	Mohanty	

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Project: Carrying out Geo-technical and Geo-Physical investigations for Kaiga 5&6, Kaiga Site, PO Kaiga, Karwar, Uttara Kannada Dist. Karnataka state

Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : BH 110

Sheet : 4 of 10

Location : TB-5 | Co-ordinates 15+4.5mTO U2 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 96.356

Total depth : 56.10 MTR | Type (s) of core barrel Double Tube. | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
20.00						57, 58, 59, 62	60, 61, 62	55, 56, 57			80% 66%	NX	72%		NX	NIL							
21.50						65, 66, 67, 68	68, 69, 70, 71,	64, 73,			70.66%	NX	52%		NX	NIL							
23.00						75, 76, 77, 80	74, 78, 79	82, 83,	Grey ish TR. with sl. slightly fractured slightly weathered Chlorite schist.		88% 80.50	NX	81.5%		NX	NIL		→ Partial					
25.00												NX			NX	NIL							

Rounded / Tukeh Chinde.

	Sohams		NPCIL	
SIGNATURE	Logged By (Geologist)	Checked By (QA)	Civil	QA
	Pachar	Pwar		

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SFE

Project: Carrying out Geo-technical and Geo-Physical investigations for Kaiga 5&6, Kaiga Site, PO Kaiga, Karwar, Uttara Kannada Dist. Karnataka state

Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110

Sheet : 5 of 10

Location : TB-5 | Co-ordinates 15+4.570 02 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 96.356 ~~95.123.8~~ mslv

Total depth : 56.10 MTR. | Type (s) of core barrel DoubleTube

Started : | Completed: | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
25.00								84,85	SP		100	NX			NX	NX							
						87,90,92	86,88,89,91,93,95		SP		100	NX	48.66%		NX	NX		Partial →					
28.00						96, 97	94,95,98		SP		91.33%	NX	91.33%		NX	NX							
30.50						99,102,103	100,101,104,SP		SP Grey, Sh, slightly fractured		99.33%	NX	83.33%		NX	NX							

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	Logged By (Geologist)	Checked By (QA)	Civil	QA
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Format No. SFE/KAIGA5&6/RD/01

Date:

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GEOLOGICAL LOG OF BORE HOLE

Hole No : 110.

Sheet : 6 of 10

Location : TB 5 | Co-ordinates (54.5M TO U) | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 96.356 (96.173)

Total depth : 56.10 MTR. | Type (s) of core barrel : Double Tube

Started : | Completed: | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
30.50						106.	105, 108.	107, 109.	Slightly weathered to fresh laminated schist, Greenish grey, Fg. Light		67.33%	NX	67.33%		NX	Nil		Partial					
32.00						111, 112,	SP, 113, 115.	110, 114			95.33%	NX	64%		NX	Nil							
33.50						118	117, 119, 121.	116, 120			71%	NX	63.5%		NX	Nil							
35.50						125	SP, 126, 127.	122, 123, 124			94.66%	NX	90.66%		NX	Nil							
37.00																							

Rubble with chunks.

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Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110 .

Sheet : 7 of 10

Location : TB-5 | Co-ordinates 15+4.5M 90 02 | Feature :

Angle with horizontal : 90° | Collar Elevation: | Existing Ground Elevation: ~~95.173~~ 96.356

Total depth : 56.10MTR. | Type (s) of core barrel Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery (0 20 40 60 80 100)	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
37.00						139,SP,133,	128,SP,129,131,SP	SP,132,134,135,SP	Slightly fractured chloritic schist.		73%	NX	40%		NX	NQ							
40.00					141,SP,142,143,144	137,138,SP,139,149	136,SP.				83%	NX	32%		NX	NQ		Partial →					
43.00						145	146,147,148.	80	Slightly to moderately weathered		70%	NX	63.5%		NX	NQ							
						149,150,152,SP	151,153,154	Core is TO															

Ramdas Shinde.
Mitesh Shinde.

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	Prachi			

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Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110 .

Sheet : 8 of 10

Location : TB 5 | Co-ordinates 5+45M 90 W | Feature :

Angle with horizontal : 90° | Collar Elevation: | Existing Ground Elevation: ~~95.173~~ 96.356

Total depth : 56.10 MTR. | Type (s) of core barrel : Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
43.00						5P, 158, 161	5P.	155, 156, 157, 159, 160, 162	Moderately fractured		96.5%	NX	74.5%		NX	NX							
45.00						163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174.			Moderately Schistic.															
						175, 176, 177, 178, 179, 180, 181.			To White, Greyish, Medium grained, Schistic.		60.33%	NX	44.66%		NX	NX		Partial →					
48.00						184, 185																	
						182, 186, 187, SP					24.66%	NX	10%		NX	NX							
49.50						183,																	

Shinde Mahadeshwar

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Rashid	Pwar		

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Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110

Sheet : 9 of 10

Location : TB - 5 | Co-ordinates 15+40M70V | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: ~~95.173~~ 96.356

Total depth : 56.10MTR. | Type (s) of core barrel : DoubleTube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
49.50						188, 190, 192, 193	191	189 SP	Highly weathered/ Schist.		71.33%	NX	51.33%		NX	NX							
51.00				SP	195, 196, 197, 198, 200, 202	199	194 SP		Highly Slightly Schistose Chlorite		80.66%	NX	74%		NX	NX		→ Partial					
53.50					203, 204, 208	205	202, SP, 207		P 3 Highly Schistose Chlorite			NX			NX	NX							
					213, 214, 209, 210, 212		208, 211, SP.		Greyish		92.88%	NX	81.07%		NX	NX							

Rahinde / Nilesh Shinde

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	Rachel			

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Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 110

Sheet : 10 of 10

Location : TB-5 | Co-ordinates 15 Mtr. SW of TB-2 | Feature :

Angle with horizontal : 90°. | Collar Elevation: | Existing Ground Elevation: ~~95.173.0~~ 96.356 mSL

Total depth : 56.10 MTR. | Type (s) of core barrel : Double Tube

Started : | Completed: | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
56.10					216,221.	218,219,220,	215,217		Slightly weathered light Grey fractured Chloritic schist.			NX.		Nil.	NX.			Partial					

Borehole terminated at 56.10

Rathode
Nilesh Rathode.

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	Rathod S.F.E.	Pawar		Lithology and Structural log Verified

Rec 23/11/18

Water Table - 2.52 m

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Date: —

Job No. — | Created By: — | Created on: —

GEOLOGICAL LOG OF BORE HOLE

Hole No: 113.

Sheet: 1 of 8

Location: TB-6 | Co-ordinates 20-4.570 U2. | Feature: —

Angle with horizontal: 900 | Collar Elevation: | Existing Ground Elevation: ~~97.745~~ 97.745

Total depth: 65.00 MTR. | Type (s) of core barrel: Double Tube

Started: 2-7-2018 | Completed: 3-8-2018 | Drilling Agency: SFE.

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
0.00									Reddish colour murum			NX			NX	Yes						3.17	
1.50																							
1.95									Red color laterite			NX			NX	Yes						1.18	15 30 45 N 8 9 11 20
4.50																							
4.95									Red colour laterite			NX			NX	Yes						0.48	15 30 45 N 10 12 21 33
7.50																							
									Sand			NX			NX	Yes		Partial				0.44	
10.50																							
									Sand			NX			NX	Yes						0.56	
13.50																							
									Sand			NX			NX	Yes						0.57	
16.00																							

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Babal S.F.E			Lithology Core photographs Log Record

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(N. MOHAN)

Total 8 Pages.

Dr. Dhansil Das (NIRM)

Total 8 pages

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Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 2 of 8

Location : TB-6 | Co-ordinates 20-4.570 02 | Feature :

Angle with horizontal : 90° | Collar Elevation: | Existing Ground Elevation: ~~97.075~~ 97.745

Total depth : 65.00MTR. | Type (s) of core barrel : Double Tube

Started : | Completed: | Drilling Agency : SPE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
16.00						1,2,	5,3,4,	SP,SP,6,SP,SP	Light Green Highly weathered Granite		54.8%	HX	15.6%	NX	NX	NX							
18.50																							
22.50						7,9,11,13,	8,10,12,	SP	Light Green moderately to Highly weathered Chlorite Schist		17%	HX	7.25%	NX	NX	NX		Partial					
24.50						14,19,	15,16,17,	SP 18.	Light Grey moderately weathered Granite		48.5	HX	21.5%	NX	NX	NX							
26.00						SP,20,22,	21,23,24,25,	SP.			41.33%	HX	28.66	NX	NX	NX							

Rounded Rough Shape

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Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 3 of 8

Location : TB6 | Co-ordinates 20-4-5 76 02. | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: ~~96.075~~ 97.745

Total depth : 65-00 MTR. | Type (s) of core barrel : Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0	20	40	60	80	100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
26.00				41,	36,37,38,39,42	25,25,28,29,30 31,32,33,34, 35								64%			NX	84%		NX	NIL							
28.00						40,			SP	Highly fractured			26.5%				NX	9.5%		NX	NIL							
30.00				43,SP,44,					SP	Grey moderately weathered			29.33				NX	NIL		NX	NIL		→ Portion					
32.00				SP,46,48,45.					SP.	TO		16%					NX	NIL		NX	NIL							
33.00						49.50			SP	Boduwithin Highly weathered Granite			38.33%				NX	10.6		NX	NIL							
35.00						el.			SP	Boduwithin Highly weathered Granite		16%,					NX	NIL		NX	NIL							

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	Bachu	Ram	mohan	

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Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 4 of 8

Location : TB-6 | Co-ordinates 20-G-5TD02 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: ~~96.075~~ 97.745

Total depth : 65.00MTR | Type (s) of core barrel : DoubleTube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0	20	40	60	80	100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Water loss: Partial	Drill Water loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
35.00						52, SP.			SP. weathered Granite			22.66					NX	Nill		NX	Nil							
35.50						SP, S3, S4,			SP.			22.66					NX	Nill										
36.00					59,	SP, S5, S6,		ST,	SP.				45%				NX	-21%			Nil		Partial					
40.00						60, 61,			SP, SP					62%			NX	Nill		NX								
40.50						62, 66,		64, 65,	SP, 63,					69%			NX	47%										
45.00					64,	68, 67, 70,			SP,	Light Grey to Green, moderately		38.66%					NX	6%		NX	Nil							

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GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 5 of 8

Location : TB-6 | Co-ordinates 20-4-5900 | Feature :

Angle with horizontal : 90° | Collar Elevation: | Existing Ground Elevation: 97.745

Total depth : 65.00 MTR. | Type (s) of core barrel Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0	20	40	60	80	100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
42.50					81,82,80.	SP,71,72,73,74,75							49.33				NX	46.66		NX	NIL							
45.00				SP.	83,84,85,86,				Light Grey to Green moderately weathered			32%					NX	0.12 %		NX	NIL							
45.50																												
47.00					89,88.								65.33				NX	15.33		NX	NIL		→ Partial					
47.50						87,89.		SP																				
48.50					90,93.			SP	Light Grey to Green moderately weathered Gneissic with Chlorite schist				45.33				NX	14 %		NX	NIL							
50.00				94,95,96,97	91,92,			SP				40.66					NX	NIL		NX	NIL							

Sohams

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Rachel	

NPCIL

Civil	QA

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Nilesh Shinde

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Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No: 113

Sheet 6 of 8

Location: TB-6 | Co-ordinates 20-4-5T0 02 | Feature:

Angle with horizontal: | Collar Elevation: | Existing Ground Elevation: ~~96.07.5~~ 97.745

Total depth: 65.00 MTR. | Type (s) of core barrel: Double Tube | Drilling Agency: SFE

Started: | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery (0 20 40 60 80 100)	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
50.00						98	3P		Light Grey to Green moderately weathered Granite with chlorite schist		42%	NX	Nil		NX	Nil							
51.50				107,108, 100,103,104,105,106							45.5%													
53.50					101,102,							NX	39.5%		NX	Nil							
						109.		3P															
55.00						110.		3P	Green, moderately weathered Granite		20.66%	NX	10.		NX	Nil		Practical					
						111.		3P	Light Grey to Green weathered Granite		49.33%	NX	6.66		NX	Nil							
56.50																							

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Rinda, Nagesh Shinde	Rachel	Pawar	Mohanty	

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Format No. SFE/KAIGA5&6/RD/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 7 of 8

Location : TB-6 | Co-ordinates 20-G.5700 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: 97.745

Total depth : 65.00MTR. | Type (s) of core barrel DoubleTube

Started : | Completed: | Drilling Agency : SFE

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
56.50					113,114,115,116,119.		112, SP.				85%	NX	89%		NX	NX							
57.50						SP.	120.	SP															
58.00						129,130,131	121,122,123,124.	SP, SP, SP	To Green, moderately weathered		50%	NX	Nill		NX	NX		Partial					
60.58						127,128,132,SP.					52%												
63.00						125,126,SP			Light Grey Granite		47.2%	NX	31.2		NX	NX							

Rohinde Nikesh Shinde

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SIGNATURE	Logged By (Geologist)	Checked By (QA)	Civil	QA
	Bachu	Pawar	mohay	

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Format No. SFE/KAIGA5&6/RO/01

Date:

Job No: | Created By: | Created on:

GEOLOGICAL LOG OF BORE HOLE

Hole No : 113

Sheet : 8 of 8

Location : TB-6 | Co-ordinates 20-4'5"N 2 | Feature :

Angle with horizontal : | Collar Elevation: | Existing Ground Elevation: ~~97.745~~ 97.745

Total depth : 65.00MTR. | Type (s) of core barrel Double Tube | Drilling Agency : SFE

Started : | Completed:

Depth, m	Elevation	Litholog: Description	Litholog: Log	Size of core pieces: <10 mm	10 mm to 25 mm	25 to 75 mm	75 to 150 mm	>150 mm	Structural Condition: Description	Structural Condition: Log	Percent Core recovery: 0 20 40 60 80 100	Type of Bit	R.Q.D. %	Facture Frequency per m	Size of Hole	Casing	Depth of water level, m	Drill Wate loss: Partial	Drill Wate loss: Complete	Permeability: Test section	Permeability: Lugeon	Penetration Rate cm/hr	Special observations & interpretations (if any)
63.00					133, 134, SP	SP, 138, 135	136, 137, 138		Light Grey to Green moderately weathered Granite		54.75%	NX	27.75%		NX	NX		Partial					
65.00																							

Bhimde Nilesh Bhimde

	Sohams		NPCIL	
SIGNATURE	Logged By (Geologist)	Checked By (QA)	Civil	QA
	S.F.E.			Lithology and structural log recorded

VOLUME: II B

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.0	SCOPE	3
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STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

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

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

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

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

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

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

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

likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the

engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

All earthwork shall be classified under the following categories:

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

a) **Ordinary Soil**

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

b) **Hard Soil**

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded

in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

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

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the

workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

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

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades

etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be

provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his

responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably 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 to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer’s prior approval on the method of pumping to be adopted shall be

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

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

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

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

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

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

3.9.0 Lighting

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

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres, alround excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre, alround excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

e) IN TRENCHES FOR BURIED PIPES & CABLES

Width of Trench

i) Upto one metre depth the authorized width of trench for excavation

shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.

ii) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical upto depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom. Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. However, any additional excavation beyond the limit specified for firm soil herein shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities as these are deemed to be included in item of work in the schedule of quantities.

iii) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.

f) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

g) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

h) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c, 5.2.0 d & 5.2.0 e) or those actually excavated, whichever, are less, shall be measured for payment.

i) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

j) Special dewatering of ground water by well point method and side protection work by sheet piling are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

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

C 0 N T E N T

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SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

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

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

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

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

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

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

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

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

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

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the

edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

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

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

		Material tests or Certificates to satisfy relevant IS Specification.
	g) Grades of Concrete:	Usage and mix design, testing of all properties.
	h) Batching & Mixing:	Types and capacity of plant, concrete mixers and transportation equipment.
	i) Joints:	Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
	j) Embedded and Anchorage Items:	Material, shape, location, setting.
	k) Placing:	Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
	l) Compaction:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
	m) Setting of base & Bearing plates:	Lines, elevations, and bedding mortar.
	n) Concrete Finishes:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
	o) Curing:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

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

3.07.00 Water-Cement Ratio

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

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable

workability	per IS: 1199		
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

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

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm

Lean concrete - 40 mm

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

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

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

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

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in-spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be

adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of

Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators

can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

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

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

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

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the

final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or

severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned

not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or 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.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in .the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be

required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

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

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to

establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the

central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be

thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard,

lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown

on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

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

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

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

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer’s satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer

surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

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

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

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

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

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

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having

three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

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

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 teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

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

5.02.00 Acceptance Criteria

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

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items

and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.

c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour

and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of

volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

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

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength

of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

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

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on

Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting

Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

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SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	6
5.00.00	RATES AND MEASUREMENTS	6

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well-seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall be made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Panelling, 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 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

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SECTION – D

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C004

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE	13
4.00.00	I.S. CODES AND STANDARDS	14
5.00.00	RATES AND MEASUREMENTS	15

ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fibre base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fibre base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fibre base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fibre based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fibre-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC 836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300%

elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkali and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane is applied.

c) Finishing coats:

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish:

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh

and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing by Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose, drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years.

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a)	IS: 73	-	Paving Bitumen
b)	IS: 702	-	Industrial Bitumen
c)	IS: 1203	-	Methods of testing tar and bitumen
d)	IS: 1322	-	Bitumen felts for waterproofing and damp proofing.
e)	IS: 1346	-	Code of practice for waterproofing of roofs with bitumen felts.
f)	IS: 1609	-	Damp-proofing Treatment using Bitumen Felts – Code of Practice
g)	IS: 3067	-	Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
h)	IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labor, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

VOLUME: II B

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-999-600-C005

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	INFORMATION TO BE SUBMITTED	9
5.00.00	I.S. CODES	10
6.00.00	RATES AND MEASUREMENTS	10

ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware's where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) “Double Plate Flush Door Shutters.”

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18-gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Jindal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15-micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one meters from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614 (Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open outside.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

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 by retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in “Schedule of Items”. Frame for steel or aluminum shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminum partition frames shall be in Kg. Paneling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in Sqm in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stops for both leaves.

   vi) Overhead door closure for both leaves.

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i)	100 mm butt hinges	- 3 Nos. on each leaf.
ii)	300 mm aluminum tower bolt	- 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.
iii)	200 mm anodized aluminum pull handle	- 1 No. of each leaf.
iv)	Door stop of approved design	- 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i)	100 mm butt hinges	- 3 Nos.
ii)	300 mm aluminum tower bolt	- 2 Nos. top & bottom of Inside face
iii)	200mm anodised aluminum Pull handle	- 1 No.
iv)	Door stop of approved design	- 1 No.

NOTE: For locks, door closures and threshold, see “Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i)	Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii)	12" peg stays	- 1 No. per leaf

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

VOLUME: II B

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006

Maharatna Company

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	I.S. CODES	4
5.00.00	RATES	5

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials:

a) Glare reducing or beat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.

g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes were six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor’s own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S. Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

VOLUME: II B

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-999-600-C007

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20-gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters

and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

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SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-999-600-C008

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of aluminium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, then those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

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.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture’s literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer’s instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.

c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.

d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consist of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than $\pm$0.05mm. all steel wire shall be hot dipped galvanised wire. The Dia. shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wires for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild

steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02 Barbed Wire Fencing

The barbed wire shall be conforming to IS:278 latest editions. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two-line wire and two-point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one-line wire (Type A - around both line wire, Type B - around one-line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75$\pm$12mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four

evenly spaced row of line wire in all. The top line wire shall be doubled, making five-line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

   i) Permissible deviation from, straightness – 1 in 1000.

   ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanized Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanized Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.
Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
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5.00.00	RATES AND MEASUREMENTS	11

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours' immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours'

immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days' work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborundum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by especially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days' work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double Chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one-layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.06.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly over burnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

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SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	I.S. CODE	8
5.00.0	RATES AND MEASUREMENTS	9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items, the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be

mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1-part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the

Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1-part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1-part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1-part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the

lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1-part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall be measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

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SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND TESTING	10
4.00.00	I.S. CODES AND STANDARDS	11
5.00.00	RATES AND MEASUREMENTS	12

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of Paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painter’s bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not be yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well-known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pre-treated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477 (Part-1) ‘Code of practice for painting of ferrous metals in building’ and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc. and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1-part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers, the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conforming to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a

hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

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, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e. Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

VOLUME: II B

SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C012

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Maharatna Company

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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3.00.00	ACCEPTANCE CRITERIA	20
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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesse rae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 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 elsewhere under the Specification. In general, all such materials shall be as per relevant 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 specialized 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 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.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish to Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still `green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may very in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to achieve the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1-part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1-part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the

topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine cannot be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1-part cement, 1-part coarse sand, 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary, the surface 'of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1-part cement and 2-part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with

a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ `Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1-part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small

quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the

thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1-part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1-part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The

joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawling, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1-part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying
Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-

mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all 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 shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm^2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1-part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The

joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to

stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall

be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally, clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form an inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, Ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

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SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-999-600-C013

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	6

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF_2) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.

iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cum. for glass wool & 48 Kg/cum. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF_2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 : Code of practice for laying of asbestos cement sheets.

IS: 2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

IS: 1626 : Specification for asbestos cement building pipes, gutters and fittings.

IS: 277 : Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.

VOLUME: II B

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

a) Plaster of Paris board (decorative)

b) Expanded polystyrene insulation board with plastic fascia.

c) Fibre Insulation board.

d) Bonded wooden particle board (Plain and decorative)

e) Glass fibre reinforced polystyrene sheets.

f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C" or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia. galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length: each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

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SECTION - D

SUB-SECTION – D15

WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-999-600-C015

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIAL	3
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	17
5.00.00	I.S. CODES	20
6.00.00	RATE AND MEASUREMENT	21

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:

a) Cast Iron pipe

b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)

c) Concrete pipe

d) Asbestos cement pipe

e) PVC pipe

f) Stoneware pipe

g) Vitrified pipe

h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) **European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) **Squatting type**

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, Part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll bolder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall

have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified, the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia.	:	1 in 35
150 mm nominal dia.	:	1 in 65
230 mm nominal dia.	:	1 in 120
300 mm nominal dia.	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be

done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 sand) which shall be rammed with caulking tool. After a day’s work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement: 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earth ware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leak-proof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating

pipe of at least 100 m dia. whose top shall he provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball 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 pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt. XVI)	:	Laying of water and sewer lines, including appurtenant items.

IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt. I & III)	:	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: 1592	:	Asbestos cement pressure pipes,
IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).
IS: 3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
IS: 4827	:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
IS: 4964	:	High-density polyethylene pipes for portable water supplies.
IS: 12701	:	Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes for Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also includes cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of “Schedule of Items”. Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in “Schedule of Items”.

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I. Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE

Maharatna Company

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	36
5.00.00	MEASUREMENT	36

Standard Technical Specification
For Road and Drainage

1.00.00 Scope

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

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

1.01.00 Works to Be Provided by The Contractor

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

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc. all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc.) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work to Be Provided by Others

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

1.03.00 Conformity with Designs

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

1.04.00 Materials to Be Used

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

2.00.00 Codes and Standards

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

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC: SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non-extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS: 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS: 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS: 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

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

2.01.00 Quality Control

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

a) Horizontal Alignment

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

b) Longitudinal Profile

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

Sub-grade ± 25 mm
Sub-base ± 20 mm
Base course ± 15 mm
Wearing course ± 10 mm

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

c) Surface Regularity of Sub-grade and Pavement Courses

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

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

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

5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

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

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

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

3.00.00 Execution

3.01.00 Setting Out

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

3.02.00 Clearing and Grubbing

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

3.03.00 Filling in Embankment

3.03.01 General

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

Table - II

Density Requirements of Embankment Materials

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

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

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

3.03.02 Setting Out

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

3.03.03 Stripping and Storing top soil

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

3.03.04 Compacting Original Ground

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

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall

be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements for Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS: 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing with Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc. and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the

pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required cross fall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-Base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note: The materials passing 425micron sieve for all the three gradings when tested according to IS: 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS: 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS: 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation's and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS: 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS: 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

S.No.	Type of Construction	Test	**Test method**	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS: 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS: 2386 (Part IV) or IS: 5640**	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value*	IS: 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS: 2386 (Part IV) or IS: 5640 **	40 percent maximum
		b) Flakiness Index ***	IS: 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS: 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However, the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75-micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading for Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS: 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the center line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be

done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS: 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates for Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS: 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS: 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS: 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS: 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS: 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading for 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading for 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportion of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self-propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tons' power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the center longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh

surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required for 10 Sq. M of Road Surface for 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However, application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material is laid, rolling shall be commenced with 6 to 8 tons' power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted

with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A: Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B: Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS: 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type a Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m. per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180-micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of

binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However, in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc. or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown

on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS: 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc. as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the

satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS: 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc. as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS: 783.

3.16.03 Relation with Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

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

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

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

i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

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

2.03.00 Codes and standards

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

IS: 226 - Structural steel (Standard Quality)

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

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

IS: 808 - Rolled steel beams, channels, and angle sections

IS: 813 - Scheme of symbols for welding

IS: 814 - Covered electrodes for metal arc welding of structural steel

IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS: 817 - Code of practice for training and testing metal arc welders

IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS: 822 - Code of practice for inspection of welds

IS: 919 - Recommendations for limits and fits for Engineering

IS: 961 - Structural Steel (High Tensile)

IS: 1148 - Rivet bars for structural purposes

IS: 1149 - High tensile rivet bars for structural purposes

IS: 1161 - Steel Tubes for structural purposes

IS: 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS: 1239 - Mild Steel Tubes

IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm)

IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (Dia, range 6 to 39 mm)

IS: 1367 - Technical supply conditions for threaded fasteners

IS: 1442 - Covered electrodes for the metal are welding of high tensile structural steel

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

IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS: 1731 - Dimensions for steel flats for structural and general engineering purposes

IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS: 1977 - Structural steel (ordinary quality) St-42-0

IS: 2062 - Steel for General Structural Purposes

IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS: 2595 - Code of Practice for Radiographic Testing

IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS: 3757 - High strength structural bolts

IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS: 7205 - Safety Code for Erection of Structural Steelwork

IS: 7215 - Tolerances for fabrication of steel structures

IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

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

2.05.00 Materials to be used

2.05.01 General

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

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and

amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

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

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural steel High Tensile

c) IS: 1977 - Structural steel (Ordinary quality) St-42-0

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

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS: 1148 - Rivet Bars for structural purpose

b) IS: 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS: 814 - Covered electrodes for metal arc welding of structural steel

b) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

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

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

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

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

2.05.06 Washers

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

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural Steel (High Tensile Quality)

c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS: 6649 - Hardened washers

2.05.07 Paints

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

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have been conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt. l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to

the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	**%**	**Remarks**
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulphur	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly, the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also require adjustment in the size of each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store

will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory

results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the

beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

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

2.12.03 Electrodes

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

2.12.04 Bolts, Nuts and Washers

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

2.12.05 Paints

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

2.13.00 Quality Control

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

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

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

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, 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.

2.14.00 Standard dimensions, forms and weights

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

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

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

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 bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information

necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

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

expert hand, subject to the approval of the Engineer.

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

3.01.04 Planning of edges

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

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

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

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

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as

specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

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

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular

section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

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

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

3.03.00 Welded Construction

3.03.01 General

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

3.03.02 Preparation of material

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

3.03.03 Assembling

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

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

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

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

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

3.03.05 Welding technique

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

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate

precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

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

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

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

3. 13.00 Separators

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

3.14.00 Bearing Plates

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

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively, diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

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

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

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

3.15.00 Shop painting

3.15.01 General

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

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

3.15.02 Inaccessible parts

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

3.15.03 Contact surfaces

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

3.15.04 Finished surfaces

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

3.15.05 Surfaces adjacent to field welds

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

3.16.00 Galvanizing

3.16.01 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 Galvanizing 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.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, 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.

3.16.03 Procedure

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

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

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

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken

not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

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

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

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

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

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

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

   i) 10% at random on fillet-joints.

   ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

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

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

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

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

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

4.05.02 Marking

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

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

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

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

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

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

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

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

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

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

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

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

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

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

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

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

a) Progress Schedule

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

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

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

5.02.00 After Award

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

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces'/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidder’s rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces'/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidder's rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However, deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted

from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

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

2.00.00 GENERAL

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

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

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

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

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

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

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

2.06.00 Storage of Materials

2.06.01 General

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

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

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

2.07.00 Quality Control

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

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

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

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

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

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

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

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

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

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

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

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

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

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

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

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

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

b) Torque Wrench Tightening

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

TABLE-II

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

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

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

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

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

3.01.09 Holes, Cutting and Fitting

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

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

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge

holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

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

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

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

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

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

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

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance

with the requirements of the specification for fabrication of structural steelwork applicable for the project.

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

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

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

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

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

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable

and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

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

4.01.02 Strength Test

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

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

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

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

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

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

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

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

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

5.01.03 Erection Yard

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

5.02.00 After award of the Contract

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

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

VOLUME: II B

SECTION - D

SUB-SECTION – D19

ROOF DECKING

SPECIFICATION NO. PE-TS-999-600-C019

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deaerator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and center to center of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self-drilling / self-tapping screws of minimum thread diameter of 5.6mm. These self-drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's

recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of damage in the sheeting.

c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 513 - Specification for cold rolled carbon steel sheets.

IS: 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS: 4431 - Specification for carbon & carbon manganese free cutting steel.

IS: 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

VOLUME: II B

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

SPECIFICATION NO. PE-TS-999-600-C020

Maharatna Company

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

C 0 N T E N T

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FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supplies of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of + 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of $\pm$ 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimize dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system

shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorized representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer’s specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks:

a. Level

b. Alignment of joints

c. Thickness of joints

d. Surface finish

e. Colour and texture

f. Details of edges, junctions etc.

g. Performance

h. Criteria specified for strength.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

VOLUME: II B

SECTION - D

SUB-SECTION – D21

BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-999-600-C021

Maharatna Company

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

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TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENTS

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pull-out loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However, no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.

2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.

2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.

2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.

2.15.00 **AVAILABLE SUB-SOIL DATA**

An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content
Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a 'particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.

4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of NX size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.

4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.

4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.

4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.

4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.

4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.

a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more then 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC

method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.

4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.

4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.09.00 Cut off level (COL)

4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.

4.09.02 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.

4.10.00 Sequence of Piling

4.10.01 Each pile shall be identified with a reference number.

4.10.02 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

4.11.00 Building up of Piles

4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

4.14.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.15.00 Recording of Piling Data

4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shell be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting

up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.

b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimen's vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified elsewhere with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.

5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.

a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to

testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.

b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.

c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.

d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.

f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.

g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as

mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be borne by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11)	-	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	-	Code of practice for plain and reinforced concrete.
IS: 1200 (Part 23)	-	Measurement of Building and Civil Engineering works Piling.
IS: 1786	-	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 1892	-	Code of practice for Subsurface Investigation for foundation.
IS: 2131	-	Method of Standard Penetration Test for Soils
IS: 2911 Part I/Sec 2	-	Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.
IS: 2911 Part IV	-	Code of practice for design and construction of pile foundation - Load test on piles.
IS: 6926	-	Code of practice for Diamond Core Drilling for Site Investigation for River Valley Projects.
IS: 10262	-	Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.

8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.

8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.

8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.

8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.

8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile location, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials,

equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.

8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.

8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tack welding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.

8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.

8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not lave been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be

considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.

8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:

i) The weight shall be arrived at by multiplying the actual length measured along with standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.

ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.

iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.

8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	**Horizontal/ Lateral (MX)**	**Pul lout/Tension (MT)**
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

a) Minimum length of the pile shall be _____* m below COL.

b) The pile shall be terminated after penetrating through the strata having SPT penetration less than __* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

a) Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.

b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____* m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.

ANNEXURE-B

List of Equipments

S. No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.

2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5.

ANNEXURE-D

PILE DATA

1. Reference No. Location (Co-ordinates) _____area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:

    i) Freshly supplied mud
    Liquid limit -

    Sand content -

    Density -

    Marsh viscosity -

    Swelling index -

    pH value -

    ii) Contaminated mud
    Density -

    Sand content -

14. SPT* N values in soil (from the nearest bore hole).
+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test
** Unconfined compression strength

15. Chiselling if any, from..….. m to ….... m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity
Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement	Stirrups: Type
No._____	No._____
Dia. _____	Dia._____
Depth _____	Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored material debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	 Slump cone test Compressive Strength test	 Each pile As per spec.	 As per Cl. 5.5 As per Cl. 5.5	 As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

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SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

SPECIFICATION NO. PE-TS-999-600-C022

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

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification covers the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc. for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also includes supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

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

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc. required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc.) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

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

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground Blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

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

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It includes all type of soil including laterite, moorum etc. with/without any percentage of kankar which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc. and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It includes the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc. and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiseling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a) Materials from swamps, marshes and bogs
b) Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e) Any material or industrial and domestic produce which will adversely affect other materials of work
f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any

approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc. shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc. within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc. with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire

woods etc. shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**
The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be

filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officerin-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.
Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities. Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot

holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc. and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc. shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc. shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one meter and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiseling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilized as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tons' roller. The approved earth/fill material shall then be spread in horizontal layers' not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as

determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc. making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed

layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections
and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting 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 edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in

stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

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SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023

Maharatna Company

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

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TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column

pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / 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.

2.02.02 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / 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.

2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.
A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 RATES

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

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.

6.00.00 I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.

NUCLEAR POWER CORPORATION OF INDIA LIMITED
(A GOVT. OF INDIA ENTERPRISE)

SPECIFICATION NO: PC-M- 00091-R0

TECHNICAL SPECIFICATION

ON

PASSIVE ROCK ANCHORS

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Note: In consideration to the fact that work from home is being implemented at NPCIL, HQ in view of lock-down due to COVID 19 pandemic and thus the technical specification is being approved electronically without affixing physical signatures.

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File Name: PC-M-00091-R0

REVISION CONTROL SHEET

DOCUMENT TYPE: ENGINEERING SPECIFICATION

NO.: PC-M-00091-R0

TITLE: TECHNICAL SPECIFICATION FOR

PASSIVE ROCK ANCHORS

REV NO & DATE	DESCRIPTION OF REVISION	REVISED BY NAME & SIGNATURE	CHECKED BY NAME & SIGNATURE	REVIEWED BY NAME & SIGNATURE	APPROVED BY NAME & SIGNATURE

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1.0 GENERAL

Passive Rock Anchors are provided to prevent/ restrict the uplift of the foundation under earthquake situation as well as to prevent flotation of structures supported on raft foundation due to buoyancy effect on account of uplift water pressure. These anchors shall be provided in the foundations of various buildings depending upon the above requirements. The rock anchors will be placed in a pattern and spacing as shown in the drawing. The rock anchors consist of

(i) Single ribbed reinforcement bar of diameter and length as specified in the drawings having minimum grade of Fe500.

(ii) Bundled ribbed reinforcement bars of diameter and length as specified in the drawings having minimum grade Fe500 welded together along their length.

Top end of single ribbed bar anchors shall be either threaded to install the anchor plate with nut or welded with the base plate(s) as per drawings. Top end of bundled ribbed bars anchors shall be suitably welded with the base plate(s) as shown in the drawing. Rock anchors shall be supplied, installed and tested in accordance with the drawings, specifications and Engineer's instructions. The scope of work shall also include providing test anchors of each type/ length. The size of the hole to be drilled in the rock for installation of the rock anchors shall be as specified in the drawing. Due care should be taken during the installation of rock anchors to ensure that there exists no possibility for formation of leakage path for ground water to come up through the space in between and around the rock anchors. A typical indicative arrangement of a passive rock anchor is enclosed at Annexure-I for general reference only.

The scope of work shall include supply, qualification, testing, installation of passive rock anchors as described above including drilling and grouting. The Contractor shall submit a detailed work procedure for approval of Engineer before carrying out the work.

The details of rock anchors system including the fixed length & free length with other system information such as sleeve details, sealing arrangement of free length portion etc. are shown in the indicative sketch enclosed at Annexure-I for general understanding. The Contractor shall supply/ install test anchors in line with the above requirement and carry out pull out test as per the procedure indicated below. In case, the test rock anchors fail to qualify the test load, the same shall be investigated. If it is established that failure of test anchors is due to in-sufficient mobilization of bond, the fixed length of the rock anchor system shall be suitably increased.

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2.0 SCOPE

The scope of work covered under this specification is as follows:

- Drilling of holes in rock at the founding level of required diameter consistent with the rock anchor system selected.
- Conducting water loss test of holes, consolidation grouting, re-drilling of holes & re-test till acceptable limit of water loss is achieved.
- Supply and fabrication of anchor rods including shot/ grit blasting and supply and application of epoxy paint with compatible primer.
- Installation of rock anchors using a non-shrinking cementitious grout.
- The Contractor shall also arrange for supply and installation of at least 3 numbers of test anchors outside the structure, which shall be tested till failure before proceeding with the installation of the working rock anchors.
- In addition to above, pull out test should be carried out in-situ in selected working rock anchors below the foundation as defined subsequently up to the working load (0.9 times the specified yield strength of the rock anchor bar/ bars) to the satisfaction of the Engineer.

3.0 CODES AND STANDARDS

Latest versions of following codes shall be applicable.

- IS 1786 (High Strength Deformed Steel Bars and Wires for Concrete Reinforcement)
- IS: 2062 (Hot Rolled Medium and High Tensile Structural Steel)
- IS: 5529-2 (In-situ Permeability Test)
- IS: 6066 (Pressure Grouting of Rock Foundations in River Valley Projects)
- IS: 11309 (Conducting Pull Out Test On Anchor Bars and Rock Bolts)
- IS: 823 (Code of Procedure for Manual Metal Arc Welding of Mild Steel)
- IS:14333 (High density Polyethylene Pipes for Sewerage)
- PP-M-1219 (Specifications for Epoxy Coating for Reactor Building Internal Structure and Equipment)
- PP-M-400 (Technical Specification for two part Polysulphide Sealing Compounds for Containment Building)

4.0 MATERIALS

The materials to be used under this specification shall be as under:

- Rock Anchors (Single and/ or Bundled ribbed bars): TMT bars of specified dia. and length conforming to IS: 1786. (Min. grade Fe500)
- HDPE sheathing conforming to IS:14333
- Mild steel plates conforming to IS: 2062
- Epoxy paint and primer as approved by the Engineer
- Non-shrink cementitious grouting compound as specified in the drawing/ specification or as approved by the Engineer. The grouting compound shall pass the pull out test as specified in this specification.

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5.0 QUALIFICATION OF ROCK ANCHOR BAR

All single and bundled ribbed rock anchor bars shall be qualified as per the procedure mentioned in the specification for reinforcement bars.

6.0 HDPE SHEATHING IN FREE LENGTH PORTION

Plain HDPE pipe/ sheath without any corrugation shall be provided in the free length portion of the rock anchors. HDPE sheath material shall conform to IS:14333 (pressure rating PN 6). HDPE sheath with appropriate capping arrangement at both ends shall be provided in the free length portion of the rock anchor such that rock anchor penetrates through these caps with proper sealing arrangement around the bar/ bars to prevent ingress of grout/ foreign material during the grouting of the hole. The top cap shall be removable for subsequent filling of free length portion with lean grout. The sheathing should be strong and corrosion resistant. If any one of the samples fails to satisfy the acceptance criteria, then re-testing shall be done for six additional numbers of samples. If any one of the re-tested samples fails to satisfy the acceptance criteria, the whole lot shall be rejected.

7.0 DRILLING OF HOLE

The rock strata at the founding level shall be cleaned and the edges of the foundation shall be marked. After laying the mud mat PCC, the location of the rock anchors in the foundation shall be accurately marked on the PCC. Holes of required diameter and depth as specified in the drawings are to be drilled. The drilling method used shall be subject to the agreement of the Engineer. Wherever ground is likely to collapse, the sides of the drill hole shall be supported by suitable lining tubes until supported by the anchor itself. Usually the depth of the hole shall be 75 mm more than the required depth of embedment of the anchor. Verticality of the holes shall be maintained while drilling. Deviation from straight shall not exceed 20 mm in any 3 m length of drill hole. Immediately after completion of the drilling, the holes shall be plugged with suitable arrangement as approved by the Engineer, until the installation of the rock anchors, to prevent entry of foreign materials or rock pieces, which may obstruct the clearance of the hole. A cement mortar bund shall be made all around the hole to prevent entry of slush.

8.0 WATER LOSS TEST AND CONSOLIDATION GROUTING

After reaching the required depth, the hole shall be cleaned and a water loss test carried out in accordance with IS:5529-2. If the water loss is more than 3 Lugeon, grouting in line with the requirements specified for consolidation grouting, shall be carried out as per IS:6066/ NPCIL technical specifications. The hole shall be again re-drilled, cleaned and water loss test re-done. The operation of re-grouting, re-drilling and water loss test shall be carried out till the water loss test shows water intake to be less than 3 Lugeon.

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9.0 FABRICATION OF ROCK ANCHORS

TMT bars of specified diameter shall be cut to the required length in a shearing machine. The fixed length, free length and embedded length in the raft foundation shall be as specified in the drawings. Flame cutting of the rods shall not be permitted. The straightness of the rod shall be checked and if required shall be rectified. In case of single bar, the anchor plate is to be installed with nuts provided in the threaded end of rock anchor or by welding as specified in the drawing. In case of bundled bars, both the bars shall be welded along their length as specified in the drawing. The top anchor plate shall be fabricated by welding. The hole in the anchor plate for insertion of the rod(s) shall be drilled using drilling machine. Cutting the hole using gas cutting set shall not be permitted. The size of weld shall be as specified in the drawings. All welds shall be visually inspected and 100% DP tested. The entire length of the rock anchor rod including the anchor plate shall be cleaned of all rust, mill scale etc. by shot/ grit blasting. Two coats of approved brand of epoxy paint of total minimum 200 micron thickness shall be applied on the entire surface, over a coat of approved primer (zinc silicate) of minimum 75 micron thickness. Care shall be taken to paint the ends of the anchor rods also. Final inspection of the anchor rods shall be offered to the Engineer-In-Charge or his representative. The bars shall be shifted to the site only after obtaining clearance from the Engineer.

10.0 INSTALLATION AND GROUTING OF ROCK ANCHORS

The hole drilled in the rock shall be cleaned using air-water jet at a pressure of 7 kg/sq.cm to remove loose particles, if any. Entire assembly of rock anchor along with the HDPE sleeve capped at both ends shall be lowered in the hole. Due care should be taken to prevent the damage of the HDPE sheath/ capping and the epoxy paint on the surface of rock anchor. While lowering the rock anchor system, PVC grout pipe of 20mm dia. unless specified otherwise for grouting shall also be attached such that grout pipe for cement grout will have to be inserted up to 75mm above the bottom of the hole.

If while lowering, the rock anchor system gets stuck, the same shall be removed and hole shall be cleaned. The hole shall be inspected for obstructions, if any, and the rod(s) shall be inspected for its straightness. Rectification measures shall be taken before attempting to lower the anchor system.

The grout materials shall be 1:1 cement sand flowing grout with approved non-shrink compound. Grout shall be mixed in a high speed mechanical mixer. Hand mixing will not be allowed. In general, the water to be used for mixing shall be potable and shall conform to relevant clause mentioned in technical specifications of concrete. The quantity of grout required to fill one anchor hole shall be mixed per batch. The mixed grout shall be pumped into the anchor hole through the grout pipe using a positive displacement pump. The grouting shall continue until the grout starts over flowing from the annular space between the sheath and the hole. Finally, space between HDPE sleeve and the bar in the free length portion shall be

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filled with lean grout (1:3 cement sand grout). If settlement of grout occurs, it shall be filled with same grouting compound.

The rock anchor shall be supported suitably on the PCC to keep it in position until the final setting of the grout.

11.0 TESTING OF INSTALLED ROCK ANCHORS

The Contractor shall initially install and test at least 3 test anchors of each type up to failure in similar site conditions. Pull out test shall be performed on the test anchors by the Contractor to determine the strength of the rock anchors after the grout attains 28 days' strength. The pull out test shall be done in accordance with IS:11309. For pull out tests, suitable arrangement shall be done at the top end of the anchor bar to grip them firmly without any slippage. The grouting compound is deemed to have been accepted if the compressive strength of the grout is not less than that for M-20 grade concrete at 28 days. Only after satisfactory demonstration of the strength of the grout, shall the grouting compound be approved for use. Load settlement graphs shall be included in the test report for submission to NPCIL. The Contractor shall submit the scheme of testing for the approval of the Engineer before taking up such tests.

After satisfactory performance of such pull out test, the main rock anchors shall be installed below the foundations of the buildings as per drawing. Pull out test of selected rock anchors up to a working load of 0.9 times the yield strength of the rock anchor system, shall be done in accordance with IS:11309 after the grout attains 28 days' strength. During the test, if any of the working anchor is not found to be satisfactory, additional rock anchors shall be installed by the Contractor.

1% of the total number of anchors, subject to rounding off to next higher digit, in any particular structure shall be selected for pull out test at the specified working load to check the quality of workmanship as described above. This test shall be conducted for all structures wherein rock anchoring is specified. Selection of such anchors shall be done by the Engineer after completion of installation of the rock anchors in the structure.

12.0 MEASUREMENT, RATE AND PAYMENT

(This para is applicable for Item Rate Contracts only and is not applicable for EPC contracts.)

12.1 DRILLING OF VERTICAL HOLES, PRESSURE TESTING/ WATER LOSS TEST AND CONSOLIDATION GROUTING

Drilling holes: Measurement of drilling vertical holes of desired diameter shall be in running meter. Separate payment shall be made for drilling holes through grouted holes of specified diameter as per rates quoted by the contractor in schedule of quantities and rates.

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Pressure testing of holes/ Water loss test: Measurement for pressure testing of holes with water to the specified pressure shall be in numbers. The quoted rates shall include supply and use of mechanical packers. Payment for pressure testing of holes shall be made as per rates quoted by the contractor in schedule of quantities and rates.

Injection/ Consolidation grouting: Measurement for injection/ consolidation grouting shall be in kg. of cement consumed in cement/ cement-sand grout. Separate measurement shall be made for injection/ consolidation grouting using cement grout (with or without mineral admixture) and cement-sand grout. The quoted rates shall include supply and use of mechanical packers. Payment for injection/ consolidation grouting of holes shall be made as per rates under the items of injection/ consolidation grouting using cement grout/ grout using cement-sand separately as quoted by the contractor in schedule of quantities and rates.

12.2 SUPPLY, FABRICATION AND INSTALLATION OF ROCK ANCHOR ASSEMBLY

The measurement of supply, fabrication and installation of rock anchor assembly shall be in RM. It will be measured from the bottom of the rock anchor to the top of anchor plate. The quoted rate shall include supply, fabrication and installation of anchor rod assembly including fabrication of anchor plate with rod(s) of minimum Fe-500 grade, carrying out DP test on welding, shot/ grit blasting, painting with one coat of Zinc silicate primer (min. 75 micron thickness) followed by 2 coats of approved epoxy paint of total minimum 200 micron DFT and installation of fabricated anchor assembly including grouting by 1:1 cement sand grout with approved non-shrink compound and grout pipe, providing and installing HDPE sheathing in free length, grouting the inner volume of HDPE pipe with lean grout (1:3 cement sand grout) and sealing the ends of the HDPE pipe with polysulphide caulking compound, all complete including all materials, labour etc as per drawings and specifications.

In case of increase in fixed length of the anchor due to bond requirement, payment shall be made as per the actual length of the anchor rod assembly supplied and installed.

If while lowering, the rock anchor system gets stuck, necessary rectification measures shall be taken before attempting to lower the anchor system at no extra cost to NPCIL. During the test, if any of the working anchor is not found to be satisfactory, additional rock anchors shall be installed by the Contractor at no extra cost to NPCIL.

If settlement of grout occurs while installation of anchor rod assembly, the Contractor shall fill the settlement with same grouting compound at no extra cost to NPCIL.

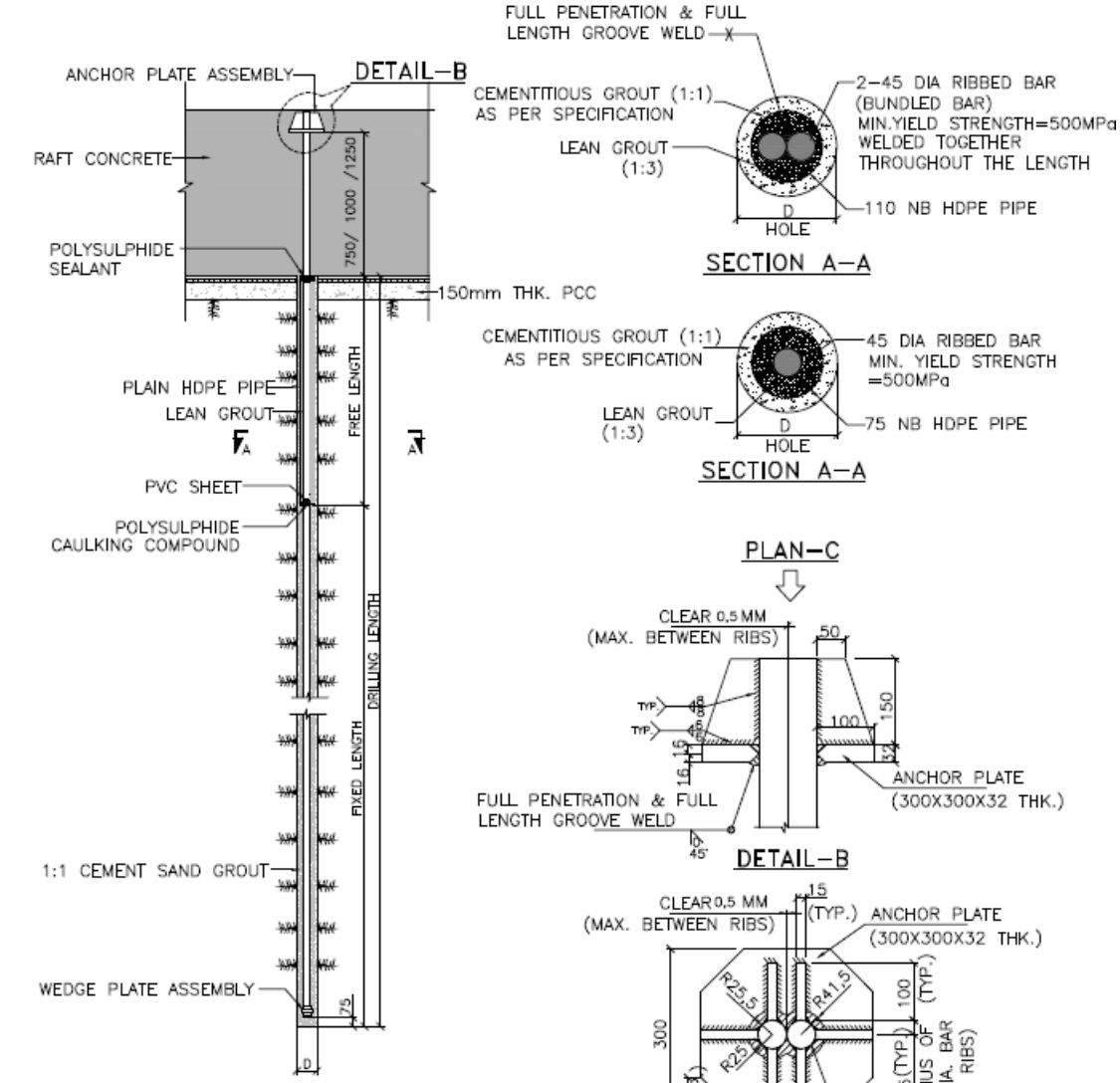
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12.3 CARRYING OUT PULL OUT TEST ON TEST/ WORKING ANCHORS

The quoted rate shall include carrying out Pull out test on test/ working anchors till failure/ working load etc. including all materials required to carry out the test, facilitating inspection/ witness of test to NPCIL all complete as per drawings, specifications and instructions of Engineer. Measurement shall be in no. of rock anchors tested and payment shall be made based on rates quoted by the contractor in SOQR for the items provided for test/ working anchors.

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Annexure-I



TYPICAL DETAILS OF ROCK ANCHORS

DETAILS OF ROCK ANCHOR :

DESCRIPTION	ROCK ANCHOR DETAILS	
BAR	1–45DIA	2–45DIA
DIA OF DRILLED HOLE(D)	125	200
FREE LENGTH	2000	2000
FIXED LENGTH	7000	7000
DIA OF PVC PIPE	75	125

Typical (Indicative) Details of Passive Rock Anchor Systems

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GUIDELINES NO. AERB/NRF/SG/IS-1 (Rev. 1)

GUIDELINES NO. AERB/NRF/SG/IS-1 (Rev. 1)

GOVERNMENT OF INDIA

AERB SAFETY GUIDELINES

CONTROL OF WORKS

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY GUIDELINES NO. AERB/NRF/SG/IS-1 (Rev. 1)

CONTROL OF WORKS

Atomic Energy Regulatory Board
Mumbai-400 094
India

December 2011

Price

Order for this guidelines should be addressed to:

The Administrative Officer
Atomic Energy Regulatory Board
Niyamak Bhavan
Anushaktinagar
Mumbai-400 094
India

FOREWORD

Activities concerning establishment and utilisation of nuclear facilities and use of radioactive sources are to be carried out in India in accordance with the provisions of the Atomic Energy Act, 1962. In pursuance of the objective of ensuring safety of members of the public and occupational workers as well as protection of environment, the Atomic Energy Regulatory Board (AERB) has been entrusted with the responsibility of laying down safety standards and enforcing rules and regulations for such activities. The Board, therefore, has undertaken a programme of developing safety standards, safety codes and related guides and manuals for the purpose. While some of the documents cover aspects such as siting, design, construction, operation, quality assurance and decommissioning of nuclear and radiation facilities, other documents cover regulatory aspects of these facilities.

Safety codes and safety standards are formulated on the basis of nationally and internationally accepted safety criteria for design, construction and operation of specific equipment, structures, systems and components of nuclear and radiation facilities. Safety codes establish the objectives and set requirements that shall be fulfilled to provide adequate assurance for safety. Safety guides and guidelines elaborate various requirements and furnish approaches for their implementation. Safety manuals deal with specific topics and contain detailed scientific and technical information on the subject. These documents are prepared by experts in the relevant fields and are extensively reviewed by advisory committees of the Board before they are published. The documents are revised when necessary, in the light of experience and feedback from users as well as new developments in the field.

Construction work is a labor-intensive industrial activity with large number of unskilled and migratory workforce under various contracts ranging from a mega package contract to a small work contract. Accidents during construction work are of major concern because of the high severity of injuries. The analysis of the accidents at construction sites indicates that 'fall from height' type of accidents are significantly higher than the other types of accidents. AERB safety guide titled 'Works Contract' (AERB/SG/IS-1) was issued in 1991 to emphasise safety requirements and ensure their implementation in execution of contracts. In view of the continual development of construction technologies and the need for enhancement of indutrial safety in DAE units, inputs from AERB discussion meets on the subject, safety and occupational health professionals of DAE, AERB Fatal accident Assessment Committee, and directives on industrial safety issued by Chairman, AERB, the need for revision of the safety guide was felt.

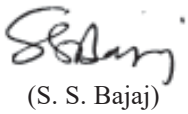
This revised 'safety guidelines' is effective from the date of issue and supersedes the earlier guide on the subject. Part-A of the revised safety guidelines highlights safety requirements by 'Facilities' and Part-B highlights the requirements on safe execution of jobs by 'Contractors'. The facility management shall be strictly liable as a principal

employer for ensuring the compliance with the safety requirements by the contractors as laid down in Part-B. It should be noted that Part-A and Part-B should be read in conjunction, as the requirements are complementary to each other. However the 'Facility' may issue the Part-B along with the tender documents. The requirements spelt out in this 'safety guidelines' are in addition to the statutory requirements such as Factories Act 1948, Atomic Energy (Factories) Rules, 1996 and other applicable statutory requirements.

Consistent with the accepted practice, 'shall' and 'should' are generally used to distinguish between a firm requirement and a desirable option respectively. Appendices are an integral part of the document, whereas bibliography are included to provide further information on the subject that might be helpful to the user.

Specialists in the field drawn from the Atomic Energy Regulatory Board, the Bhabha Atomic Research Centre and the Nuclear Power Corporation of India Limited and other consultants have prepared this 'safety guidelines' document. It has been reviewed by the Advisory Committee on Industrial and Fire Safety (ACIFS).

AERB wishes to thank all individuals and organisations who have prepared and reviewed the document and helped in its finalisation. The list of persons, who have participated in this task, along with their affiliations, is included for information.



(S. S. Bajaj)
Chairman, AERB

SPECIAL DEFINITIONS
(Specific for the Present 'Guidelines')

Approval

A type of written consent issued by the designated authority.

Construction Agency/Contractor

An individual or organisation rendering services of design/construction/fabrication/ installation/repair/inspection/review/maintenance/supplying items by the deployment of workers at site.

Dangerous Manufacturing Processes or Operations

The manufacturing processes or operations as specified under Rule 88 of the Atomic Energy (Factories) Rules, 1996.

Engineer-in-charge

A person designated by the Facility to act as an overall in-charge of work.

Facility

Any Unit of the Department of Atomic Energy awarding the contract.

Head, Industrial Safety

The chief safety officer or the overall in charge of Industrial Safety Section of the facility.

Line Managers

The person who has the field level managerial and supervisory control on the concerned work.

Safety Related Deficiency

The unsafe acts/unsafe practices/unsafe conditions in the work area, which have potential to cause injury/accident resulting into undesirable consequences to human beings or damage to the equipment/property/environment.

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PART-A

CONTROL OF WORKS
(FACILITIES)

1. INTRODUCTION

1.1 General

Department of Atomic Energy (DAE) through its constituent units execute various site works either by their own manpower or by manpower of various outside agencies. The nature of contracts with outside agencies can be works contracts, engineering procurement contracts, minor fabrication contracts etc. These site works involve entire gamut of conventional industrial activities like excavation, rock blasting, earth handling, construction, material handling, fabrication, installation, operation, maintenance etc. of nuclear or conventional plants/facilities. This is a challenging responsibility for the facility due to the complexity of problems like quality of workforce (which may be unskilled, illiterate, migratory) available for labor-intensive jobs, lack of coordination among agencies at site, lack of safety awareness among concerned authorities, time schedules of project etc. As primary employer of the workforce (facility or contractor) at site, it is the responsibility of the facility management to ensure health and safety of personnel engaged for the work. Any accidental injury or loss of life is detrimental to the facility as well as the society. This 'guidelines' covers the safety organisation and the safety management system requirements in sections two and three. The work specific safety precautions are covered in section four. The requirements relating to personal protective equipment and medical management are covered in sections five and six.

1.2 Objective

This 'guidelines' has a basic framework of industrial safety organisation, safety management systems, safe work procedures to maintain a safe working environment for all personnel and to prevent any unsafe condition/act endangering the life of personnel engaged for industrial activities. The major objectives of this 'guidelines' are:

(i) To create awareness among workers about industrial hazards and safe working procedures.

(ii) To lay down safe work procedures and systems to be followed for different type of industrial activities

(iii) To establish a robust safety management system.

(iv) To protect the health and ensure the safety of the workers from industrial activities.

1.3 Scope

This 'guidelines' is essential for implementation and assurance of conventional safety in areas such as industrial, chemical, electrical, fire, environmental and is applicable for all works taken up by the facility as well as contracted works like engineering procurement contract, minor fabrication contract etc. Where the execution of work is envisaged in radiation controlled area or involves handling and fabrication of any nuclear material, additional precautions noted in relevant AERB safety documents on radiation protection shall also be applicable.

2. SAFETY ORGANISATION

2.1 General

(a) Construction projects have significant health and safety hazards, which need to be managed systematically since the project inception stage to achieve adverse incident free completion. A well-defined safety organisation helps in effective implementation of safety management systems and ensures health and safety of workers.

(b) The safety organisation should assure the management that all the provisions of relevant Acts and Rules are conformed to.

(c) Safety organisation should comply with all the requirements such as safety surveillance, safety training, safety enforcement measures, safety audit etc. related to all works to fulfill the overall safety requirements of this 'guidelines'.

(d) Safety functionaries should be exclusively assigned with the work related to protection of health and safety of workers.

(e) Safety organisation should directly report to the Project Director / Project Manager.

(f) IS: 18001: 2007 gives detailed requirements of health and safety management system requirements. IS: 15793 gives requirements of good practices for managing environment, occupational health and safety legal compliance. This 'guidelines' prescribes requirements in addition to IS: 18001: 2007 and IS: 15793 and gives guidelines on implementing these specific to a construction project.

(g) The requirements prescribed in various central and state regulations including *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996 and rules framed thereunder with respect to managing health and safety in construction projects, shall be complied with.

2.2 Organisational Structure for Safety Management

(a) Organisational structure depends on the construction project. As an example, a typical organisational chart for safety management in a construction project would be as given in Fig 1.

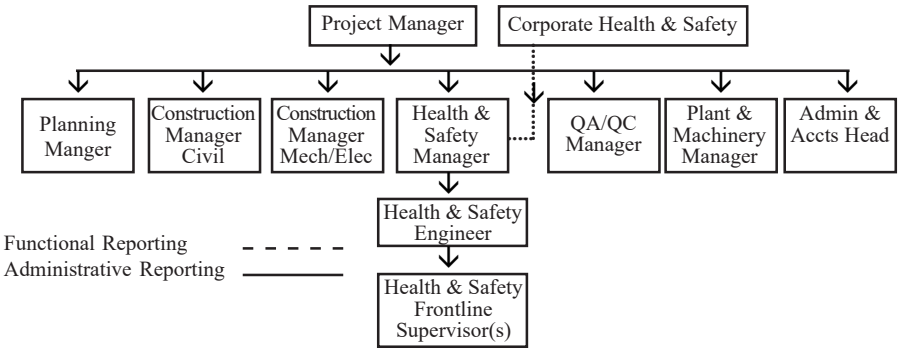


Fig -1 : Typical Organisation Chart

(b) The organisational structure for Health and Safety will vary from project to project. On large and medium projects, it may be necessary to have a separate safety team for each sub-contractor who in turn shall report to safety team of the main construction agency.

(c) The qualification, experience and the minimum number of safety professionals to be deployed should be as per the following table:

TABLE-1 : QUALIFICATION, EXPERIENCE & NUMBER OF SAFETY PROFESSIONALS FOR CONSTRUCTION PROJECTS

Category of safety person	Mandatory requirement	Qualification
Head, industrial safety	One at each site/unit	Degree in engineering/technology and diploma in industrial safety with minimum three years of experience
Safety officer	One in each shift (minimum) up to 1000 workers. If number of workers in a shift (including contractor's workers) exceeds 1000, additionally one safety officer should be deployed for every 1000 workers or part thereof.	Degree in engineering/technology and diploma in industrial safety with minimum two years of experience or Diploma in engineering with diploma in industrial safety with minimum 6 years experience or A recognised degree in physics or chemistry and has practical experience of working in a factory in a supervisory capacity for a period of not less than 5 years.

Category of safety person	Mandatory requirement	Qualification
	One in each shift (minimum) up	Not withstanding the provision contained in the above criteria any person who (i) possesses a recognised degree or diploma in engineering or technology and has had experience of not less than five years in a department of the central or state government which deals with the administration of the Factories Act, 1948 or the Dock Workers (safety, health and welfare) Act, 1986 (54 of 1986) or (ii) Possesses a recognised degree or diploma in engineering or technology and has had experience of not less than 5 years, fulltime on training, education, consultancy, or research in the field of accident prevention in industry or in any institution, shall also be eligible for appointment as a safety officer: Provided that competent authority may, subject to such condition as it may specify, grant exemption from the requirement of this sub rule if in its opinion, a suitable person possessing the necessary qualification and experience is not available for appointment.
Safety supervisor	to 500 workers. If number of persons working in a shift (including the contractors' workers) exceeds 500, additionally one safety supervisor should be deployed for every 500 workers or part thereof.	Diploma in engineering and diploma in industrial safety

3. SAFETY MANAGEMENT

3.1 General

(a) Pre-construction stage activities of the project shall be required to be reviewed before the project management processes are initiated for the construction stage. While the project documents and proposals are reviewed for the adequacy of health and safety measures, it is essential to ascertain timeframes and budgets relating to health and safety measures, including extent of management systems proposed to be employed during construction.

(b) A concise safety management system of the facility shall be established from the pre-construction stage itself. The tender documents of the project shall clearly communicate the health and safety requirements of the project to the prospective contractors. These may include:

(i) Project specific objectives and targets

(ii) Project specific health and safety requirements (technical as well as management systems)

(iii) Requirement of posting safety officers

(iv) Coordination among owner/client, project manager, consultants and facility

(v) Welfare facilities at the project for workmen

(vi) Reward system for good health and safety performance

(vii) Penalty system for non-compliances, violation and adverse incidents

(viii) Health and safety monitoring measures

(ix) Health and safety reports to be submitted and frequency.

(c) The construction agencies (contractors) should be asked to submit a project specific health and safety plan (construction safety management plan) proposing the methodology for managing health and safety and their capability in completing the project in a safe manner.

(d) The proposed construction safety management plans of the construction agencies and their past health and safety performance shall be considered as one of the criteria during pre-qualification and selection of construction agencies.

3.2 Safety Policy

(a) The facility and the construction agency jointly or separately shall have a written statement prescribing the health and safety policy of the organisation. The health and safety policy conveys the management commitment and intent of the organisation towards health and safety, its organisation and arrangements to ensure that the set objectives are met. It also provides a framework for establishing, maintaining and periodically reviewing health and safety objectives and targets.

(b) Health and safety policy shall meet the requirements of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996 and IS 18001.

(c) The policy shall be communicated to all stakeholders through display and other means. The policy shall be displayed in local language(s) which may be understood by majority of the workmen.

3.3 Safety Plan

(a) A project specific health and safety plan shall be developed by the facility. On approval by the project director, the project health and safety plan shall be reference document for implementation, control and monitoring of health and safety aspects of the project by the facility.

(b) Project health and safety plan shall describe how the project specific health and safety objectives and targets shall be achieved. It shall define the road map for achieving the standards that an organisation lays down for itself so that efforts can be coordinated, synergised and monitored.

(c) Health and safety plan shall explain the means of establishing a positive health and safety culture at the project site. Health and safety plan shall identify and enumerate the control measures to mitigate the risks to the project completion arising out of health and safety issues so that the project is allowed to proceed without interruption and executed as per schedule.

Salient aspects that may be covered in the project health and safety plan are:

(i) Project specific health and safety objectives, targets and programmes in line with health and safety policy

(ii) Hazard identification and risk assessment

(iii) Meeting legal and other requirements

(iv) Health and safety organisation

(v) Resources, roles, responsibility and authority

(vi) General health and safety rules

(vii) Health and safety requirements to be followed by sub-contractors

(viii) Operation control procedure

(ix) Activities requiring work permit system and its procedure

(x) Safe handling of chemicals, explosives, gas cylinders, electrical equipment etc.

(xi) Access control of employees

(xii) Safety of visitors

(xiii) Management of critical activities such as work at height, material handling and working with plant and machinery

(xiv) Ensuring the competency and awareness of the workmen

(xv) Fire prevention and fire fighting plan

(xvi) Emergency preparedness and response plan

(xvii) Traffic management plan

(xviii) Training matrix

(xix) Personal protective equipment matrix

(xx) Health and safety performance monitoring measures such as inspection and audit

(xxi) Incident reporting and investigation procedure

(xxii) Proactive and reactive indicators of health and safety

(xxiii) Reward and reprimand for health and safety performance

(xxiv) Checklist and formats

(xxv) Health monitoring plan for employees/workers enposed to hazardus job.

(d) The risk control measures identified shall meet the provisions of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996, other legislations and provisions of various safety related standards.

(e) Procedures shall be established for timely recording and reporting of information required for continual improvement of health and safety performance. Internal reporting procedures shall cover:

(i) Incident reporting

(ii) Non-conformance reporting

(iii) He alth and safety performance reporting

(iv) Hazard identification reporting

External reporting shall cover

(i) Statutory reporting requirements

The recording of reporting of health and safety performance shall be clearly documented in the project health and safety plan.

3.4 Roles, Responsibility and Authority

(a) Project manager shall define, document and communicate the roles, responsibilities and authorities of all personnel who manage, perform and verify activities having an effect on health and safety risks. It shall also include contractors and visitors.

(b) Ultimate responsibility for health and safety shall rest with top management of the respective organisation.

(c) The line management personnel who are responsible for execution of activities are directly responsible for health and safety in the work under their control.

(d) Health and safety group and health and safety officers are responsible for guiding the top management on health and safety issues and facilitating the implementation of health and safety in the project site. For duties and responsibilities of health and safety officers refer Atomic Energy (Factories) Rules-1996.

(e) Health and safety officers shall administratively report to the project manager and functionally report to the senior health and safety representative of the organisation.

(f) Health and safety officers and health and safety group shall be empowered by the project manager for stopping any unsafe practices which are of imminent danger to employees. Health and safety group shall directly report to no less than the head of the project.

(g) Health and safety supervisors shall be engaged to assist the health and safety officers in performing their duties.

(h) Management shall provide adequate resources essential to effectively manage the health and safety requirements of the project. The resources shall include human resources, organisational infrastructure, technology and financial resources.

3.5 Design and Engineering

(a) Design drawings, construction methodology and plans shall be reviewed to determine whether any additional risks may arise during the construction due to the features in the design or methodology.

Attention shall be paid to:

(i) Providing permanent hooks and loops for tying safety slings of workers

(ii) Providing holes or such arrangements to the structure to which safe working platforms and safety nets can be connected

(iii) Significant risks from construction materials, which cannot be avoided in the design

(iv) Laying permanent slings, grab rails/bars to be used by the workers

(v) Permanent provision for attaching railings

(vi) Provision for alternative access to the trapped or distressed workers

(vii) Provision for communication

(viii) Design facilitating barricading of the area around work site without causing hindrance to building functional activities

(ix) Durability of such safety related permanent design integrated elements

(x) Other safety practices required for the type of woks involved.

(b) Analysis of design and integration of safety measures, as described above, should be undertaken as value engineering through multi-stakeholder consultation, necessarily involving designers, owner/ client, operation/maintenance management and construction agency.

(c) While need for special work methodology and enabling infrastructure is considered to make conditions safe for construction, attention shall also be drawn to the safety during maintenance operations (including inspections which may be necessary before project commissioning as well as maintenance).

(d) It shall also be ascertained whether it would be feasible (within the time and cost considerations) to erect necessary temporary enabling infrastructure. If, in the due assessment by the project manager, it is established that the design, as proposed, would continue to be unsafe during construction and maintenance operations unless special

enabling infrastructure is created and work procedures specifically drawn, the design shall be reviewed.

3.6 Construction Planning

(a) Prior to the start of construction work, detailed planning shall be carried out which may include:

(i) Identifying aspects of design that have bearing on health and safety during construction stage.

(ii) While scheduling the various activities of the construction, allowing adequate time to carry work in accordance with health and safety requirements.

(iii) Reviewing the proposed work method of various activities, identifying health and safety hazards of activities in the project and assessment of the risk level.

(iv) When the risk level is unacceptable, taking additional control measures including revision of the work methodology so that identified risk is at ALARP (as low as reasonably practicable) level.

(v) Planning and establishing the facilities for implementation of health and safety such as workmen training facility, health centre for medical check-up and first aid, access control of employees, etc.

(vi) Ensuring that the temporary establishments at project site such as site offices, workmen camps, toilets, canteens and rest sheds, etc. are created meeting the requirements of the relevant statutes and standards.

(b) Facility shall ensure that the construction agency has understood the challenges and has planned to meet the project specific health and safety requirement through appropriate competencies.

(c) Health and safety measures need proper coordination by the construction agency and such efforts of the construction agency shall be reviewed, monitored and appropriately guided by the facility.

(d) In respect of sub-contractors, project manager of the construction agency shall ensure that the sub-contractors meet the health and safety requirements of the project. Health and safety control and monitoring shall be established specific to the needs of the project.

(e) Past health and safety performance and capability of contractors to complete the job safely shall be given due consideration during selection of contractors. The project specific health and safety

requirements shall be clearly communicated to the contractors and a commitment obtained from them on meeting the requirements.

3.7 Safety Communication

(a) Procedures shall be established to communicate significant hazards and risks to and from employees and other interested parties. The health and safety hazards and risks may be communicated in the following ways:

(i) Sharing of accidents case studies which occurred in the project site as well in other similar projects

(ii) Health and safety posters and displays

(iii) Health and safety campaigns and competition involving the employees

(iv) Sharing of results of the audits, inspections and other monitoring systems

(v) Establishing a system for collecting feedback on health and safety from employees and other interested parties

(vi) Tool box meeting

(vii) Safety signage.

(b) Health and safety communications addressed to workmen shall preferably be in local language(s) understandable by majority of the workmen.

(c) The owner/client, consultant and construction agency shall jointly endeavour to promote a positive health and safety culture at the project. Top management of the organisations should exhibit a visible management commitment and felt leadership towards health and safety. This shall be achieved by participating in health and safety programmes such as,

(i) Project health and safety committee meeting

(ii) Health and safety walk down

(iii) Including health and safety in all performance review meetings

(iv) Exhibiting a safe behaviour while at site.

(d) The top management should clearly communicate that it considers safety as core value and it shall not allow it to get compromised. Such messages when it reaches down the level in the organisation enable to create a positive health and safety culture.

3.8 Safety Monitoring Programme

(a) The objective of the safety surveillance programme should address

assurance of effective implementation of safety measures in execution of works. Following surveillance programme should be in place at sites. The safety organisation should monitor, maintain record and follow up for corrective actions.

(b) The surveillance programme should consist of identification of safety related deficiencies and status of corrections thereof, the implementation of protective measures, the safe work practices, human behavior etc.

(c) Specific surveillance should be ensured with respect to testing of equipment, portable power tools, electrical equipment and tools, hand tools, surveillance of material handling equipment, transport equipment, earth moving equipment, gas cylinders etc. to comply with various statutory requirements.

(d) Surveillance on safety awareness and training compliance including induction training, on the job training and refresher training, job specific pre-job briefing, job hazard analysis, etc. as per facility's guidelines should be ensured.

(e) Safety related deficiencies should be detected by any employee of the facility and communicated by the safety officer to their line managers with a record and corrective measures monitored and recorded. The engineer-in-charge should specifically ensure this. These should be informed to Head, Industrial Safety within the stipulated time period as per the category of safety related deficiencies (SRDs).

(f) Systematic record of safety related deficiencies (SRDs) attended and pending should be made by the facility and other executing agencies.

(g) Head, Industrial Safety should verify periodically, at least once in 15 days that all safety related work permits issued are executed and recorded.

(h) The health and safety performance monitoring and measurement procedures shall provide for:

  (i) Both qualitative and quantitative measures appropriate to the project

  (ii) Monitoring the extent to which project health and safety objectives are met

(iii) Proactive measures of compliance that measures compliance with health and safety plan, operational control procedures and legislation

(iv) Reactive measures of performance to monitor accidents, ill health, near misses and non-conformances

(v) Monitoring dangerous occurrances

(vi) Fire occurrances

(vii) First aid injuries.

(i) Health and safety audit is a systematic and independent examination to estimate if planned arrangements and activities are effectively fulfilling organisation's health and safety policy, plan and objectives. Its purpose is to find out:

(i) Whether the organisation has adequate procedures for identifying specific health and safety requirements

(ii) Whether such laid down procedures are followed and specific health and safety responsibilities are understood

(iii) Whether health and safety policies and risk assessment procedures identify the measures needed to avoid risks to employees and other interested parties

(iv) Whether the company has adequate procedures for devising, reviewing its health and safety standards

(v) Whether the company's health and safety standard identifies measurable targets

(vi) Whether the company has established adequate procedures for planning, implementing, controlling, monitoring and reviewing the health and safety measures.

(j) Project health and safety management audits provide the method for monitoring and controlling health and safety activities and procedures throughout the life of the project. Audits can be internal or external. Internal audit can be conducted by the persons from the same organisation who are not directly connected with the work site to be audited. The external audits are performed through external professional experts.

(k) Health and safety inspections shall be preferably conducted by a team of the concerned engineer, health and safety officer and area in-charge. Project manager and other senior personnel shall also join in some of the health and safety inspections.

(l) The type of inspections that shall be carried out and the frequency shall be decided during the planning stage and documented in the project health and safety plan. The health and safety inspections should include:

(i) General site health and safety inspection

(ii) Electrical safety inspection

(iii) Plant and machinery inspection

(iv) Health and hygiene inspection

(v) Scaffolding safety inspection

(vi) Portable tools and tackles

(vii) Lifting tools and tackles

(viii) Fire equipment inspection

(ix) Illumination level and noise level monitoring

(m) Project health and safety committee shall be constituted with project manager as the chairman, health and safety head as the secretary and representatives from various groups including workmen representatives as the members. The constitution and functioning of the committee shall meet the provisions of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996.

(n) This committee shall review the status of implementation of project health and safety plan, health and safety objectives and targets. Health and safety indicators and findings of the walk down by the committee members shall also be discussed and action plan derived.

(o) Status of health and safety implementation shall be measured and monitored by several proactive indicators which include the following:

(i) Compliance level of project health and safety plan

(ii) Compliance level of health and safety observations with in the target date

(iii) Implementation status of training plan

(iv) Implementation status of corrective and preventive actions

(v) Compliance level of pre-employment medical checks and periodic medical checkups

(vi) Compliance level of legal and other requirements

(vii) Percentage of activities for which detailed project specific risk assessment is conducted.

(p) Procedures shall be established to report, investigate and analyze incidents. The procedures shall involve:

(i) Members of the incident investigation team

(ii) Agencies to be reported in case of incidents

(iii) Time period within which incidents need to be reported

(iv) Methodology for investigation and determining the root cause of accidents.

These procedures shall form a part of the project health and safety plan and monitored on a regular basis for its effectiveness.

(q) All incidents including near miss cases, accidents and dangerous occurrences shall be thoroughly investigated, direct and root causes determined and corrective action planned. Incidents should be analysed covering the following ways to prepare and implement an effective prevention plan:

(i) Body part injured

(ii) Age of the victims

(iii) Time of accidents

(iv) Causes of accidents

(v) Nature of injury.

For detailed guidelines on analysis of incidents and computation of injury rate refer IS 3786.

(r) The following reactive health and safety indicators should be used to measure and monitor the health and safety performance of the project site:

(i) Number of near miss cases

(ii) Number of first aid cases

(iii) Lost time injury frequency rate

(iv) Lost time injury severity rate.

(s) The health and safety performance of contractors shall be monitored on a regular basis and necessary directive and support shall be given to achieve the set health and safety objectives and targets.

(t) All accidents leading to property damage/fatal accidents/personnel injuries/near miss and dangerous occurrence should be reported to the engineer-in-charge immediately.

(u) All 'near-miss' accidents should also be recorded/reported and investigated and recommendations arising out should be implemented on priority.

(v) Facility/Contractor should also submit a monthly statement of accidents to engineer-in-charge/head, industrial safety by 4th of the following month showing details of accident, nature of injury including disability, days lost, treatment required, etc. and the extent of property damage.

3.9 Training/Orientation

(a) It shall be ensured that all employees are competent to perform the assigned work safely on the basis of appropriate education, training or experience. The competency requirements of different categories of employees shall be mapped and procedures shall be implemented to ensure that those deployed meet the competence requirements.

(b) Training needs of the different category of employees shall be identified at the beginning of the project and a training matrix and plan shall be prepared for implementation.

(c) The objective of health and safety training shall be to equip the employee with necessary knowledge and skill to perform the work assigned to him in a safe manner, to foster continual improvement and to imbibe safety culture.

(d) Preferably, the training should be carried out away from the working place of the participants to ensure focused attention on the training for both trainer as well as trainees.

(e) After completion of training due procedure shall be followed for obtaining the feedback from the participants on the effectiveness of the training. Effectiveness of training imparted shall be monitored for continual improvement and necessary corrections in implementation.

(f) The training/orientation programme should be implemented to meet the mandatory requirements. [Rule 43(2) (m) of the Atomic Energy (Factories) Rules 1996]. The training should be phased as follows:

(g) Induction cum orientation training should include the overall safety aspects of the work and give a general overview of the various hazards, the particular activities and the do's and don'ts. As a part of training, workers should also be given demonstrations on use of

personal protective equipment, first aid, fire-fighting equipment, fire mock drills, other emergency preparedness etc.

(h) The line manager along with the safety representative should conduct pre-job briefing on day-to-day basis prior to specific hazardous jobs. This will make the workers aware of the hazards and the precautions to be taken.

(i) Refresher training should be imparted to each worker at least once in a year.

(j) A training schedule should be prepared by the facility for implementation.

(k) Records of training, demonstration and pep talk should be maintained.

3.10 Permit to Work System

(a) Activities requiring permit to work shall be decided before starting the construction and shall be suitably documented in the project health and safety plan. Some of the activities which should require permit to work are:

(i) Excavation

(ii) Entry into confined spaces

(iii) Electrical work (HV/LV)

(iv) Opening manholes, covers and grills

(v) Blasting operation

(vi) Hot work

(vii) Work on plant and machinery & other power driven equipment

(viii) Working at height

(ix) Working at night

(b) The facility should establish a permit to work system for any other hazardous activity, which it feels necessary to be controlled administratively for safe execution.

(c) Record of safety work permit should be maintained in a systematic manner. All the safety conditions and requirements stipulated in the safety work permit should be ensured strictly.

(d) Occupier should ensure that only authorized personnel are deployed for hazardous works/jobs (Refer item 3.11 for hazardous job) and provide facilities for the same.

3.11 Job Hazard Analysis

(a) It should be ensured that a safe work procedure exists for all the hazardous jobs as mentioned hereunder and the requirements of the safety procedures are ensured at the work sites. Job hazard analysis (JHA) should form a part of such safe work procedures. A checklist based on JHA should be prepared. This checklist should be crosschecked by the line managers and verified by safety officer.

Typical list of jobs requiring job hazard analysis (this list is illustrative only and not exhaustive) is as follows:

(i) Excavation

- (a) Blasting including under water blasting
- (b) Earth and stone removal/backfilling/dumping of earth/stones
- (c) Any excavation more than 1.8 m depth.

(ii) Work at height (working beyond 3.5 meters above ground)

- (a) Erection and dismantling of scaffolding, platforms, shuttering/ de-shuttering work
- (b) Dome work, rod bending, construction of chimney and cooling towers
- (c) Working on tower crane.

(iii) Materials and material handling

(A) Critical equipment handling e.g.

- (a) Calandria
- (b) Steam generators
- (c) Turbine generator components
- (d) Diesel generator set
- (e) Generator stator
- (f) End shields
- (g) Fuelling machines components
- (h) Heat transport pumps etc.

(B) Hazardous chemical handling e.g.

- (a) Acids and alkalis
- (b) Chlorine

(c) Hydrazine

(d) Morpholine

(e) Freon

(f) Ammonia

(g) LPG

(C) Movement of heavy material by crane

(D) Movement of tractor trolley on slopes

(E) Manual lifting of heavy material to height

(F) Erection of heavy machinery, equipment.

(iv) Electrical connection

(a) Field connection for electrical installation

(b) Installation of lighting fixtures

(c) Charging of electrical system

(i) Charging of transformer, switch yard, switch gears

(ii) Working near high voltage lines

(iii) Use of portable electrical tools.

(v) Equipment/structural erection work

(a) Material handling

(b) Loading and unloading

(c) Transportation of material from one place to other

(d) Steel fabrication and erection

(e) Cleaning and maintenance of batching plant equipment.

(vi) Finishing/painting work

(a) Painting at height

(b) Painting in confined space.

(vii) Other specific work

(a) Work with pneumatic tools/compressed air

(b) Work on pressure vessels/lines

(c) Work in the vicinity of steam lines

(d) Work in high enthalpy area

(e) Work in high noise area

(f) Work in confined space including tunnels & trenches

(g) Work in isolated area (away from main site)

(h) Radiography work

(i) Work related to welding, gas cutting, grinding

(j) Working near conveyor, rotating machine

(k) Leak detection testing.

3.12 Reward and Reprimand

(a) It is important to acknowledge and encourage good health and safety performance and suitably reprimand repeated violations, non-conformances and poor health and safety performances. Project specific reward and reprimand system shall be prepared as a part of the project health and safety plan.

(b) To motivate the employees and organisation to work safely measures can be implemented based on the suitability. Selection and rewarding for the following categories may be considered on regular basis:

(i) Safest workmen

(ii) Safest supervisor

(iii) Safest area

(iv) Safest contractor, etc.

(v) Contractors and employees may be rewarded when the project achieves significant million man-hours without any lost time injury.

(c) Unsatisfactory health and safety performance in the form of repeated violations, frequent adverse incidents and accidents shall be dealt with firmly. Depending on the seriousness of the violation the following options shall be considered:

(i) Issue of violation memorandum and obtaining written commitment for safe working

(ii) Suspension or termination of the employee from the present work

(iii) Suspension or termination of contract in case of construction agency

(iv) Imposition of penalty to the construction agency.

(d) When penalties are imposed due records shall be maintained in a transparent manner. The main contractor shall be responsible wherever he deploys sub-contractor/petty contractor/piece rate contractor. The funds thus accrued may be spent in the form of rewarding employees for their sincere efforts towards improving the health and safety performance.

4. WORK SPECIFIC SAFETY SAFETY MEASURES

4.1 General

(a) The occupier should ensure that safety precautions are taken during the execution of awarded work and work areas are maintained safe at all times. At the end of each shift and at all times when the work is suspended, it should be ensured that the work area is left safe in such a way that no materials and equipment that can cause damage to existing property, personal injury or interfere with the other works of the project or station are left in an unsafe manner.

(b) The occupier should ensure to provide and maintain all lights, guards, fencing, warning signs, caution boards and other safety measures and provide for vigilance as and when necessary for the protection of workers and for the safety of others. The caution boards should also have appropriate symbols.

(c) Adequate lighting facilities such as floodlights, hand lights and area lighting should be provided at the site of work, storage area of materials and equipment and temporary access roads within the working area.

(d) All works should be planned so as to avoid interference with other facilities, works of other contractors or sub-contractors at the site. In case of any interference, necessary coordination should be ensured for safe and smooth working.

(e) It should be ensured that the instructions given by the safety officer or his designated nominee regarding safety precautions, protective measures, housekeeping requirements, etc. are complied with. The safety officer with due intimation to engineer-in-charge should have the right to stop the work, if in his opinion, proceeding with the work will lead to an unsafe and dangerous condition. Engineer-in-charge should arrange to get the unsafe condition rectified and/ or provide appropriate protective equipment.

(f) Engineer-in-charge should ensure that each job with a hazard whether small or big is intimated to the safety officer of the facility well before it is taken up.

(g) The facility should be fully responsible for non-compliance of any of the safety measures or requirements, implications, injuries, fatalities, dangerous occurrences and compensation arising out of such situations or incidents.

(h) Maximum duty hours of an individual should be as per the Factories Act 1948 or its latest amendment.

(i) Illumination levels should be as per the statutory requirements.

4.2 Rock Blasting

(a) All blasting operations should be carried out on the basis of procedures approved by Head, industrial safety and engineer-in-charge. All works in this connection should be carried out as per BIS specification/code (IS 4081: 1986. Title:- Safety code for blasting and related drilling operations (First Revision)). Barricades, warning signs etc. should be placed on the roads/open area.

(b) Blasting permit should be obtained from Head, industrial safety at least one day before the blasting operation and precautions mentioned there in shall be ensured by the engineer-in-charge before blasting operation.

(c) The blaster should have a licence from competent authority under Explosive Rules, 1983 for blasting work. It should also be ensured that he knows about the risks involved.

(d) Blasting should be done under the supervision of competent engineer/ supervisor.

(e) Blasting in the open site should only be carried out during fixed hours every day/fixed day in the week between sunrise and sunset. Residents of adjacent area should be informed in advance about the blasting schedule.

(f) No blasting should be undertaken during thunderstorm.

(g) Necessary precaution should be taken to ensure the stability/integrity/ safety of the adjacent structure by limiting the peak particle velocity.

(h) No loose material, such as tools, drilling equipment, etc. should be left on the surface to be blasted. Proper muffling arrangement of the blasting area should be ensured to avoid flying of blasted material.

(i) Authorised blaster should personally ensure that all the personnel/ equipment has been removed from the blasting area before the blasting operations.

(j) Blasting area should be free of detonating gas, inflammable objects, sparking or damaged wiring system, stray currents and static electricity.

(k) All electrical lines in blasting area should be de-energised.

(l) Entry of unauthorised personnel should be prevented by displaying warning signs.

(m) In case of misfire, no person should be allowed to approach the blasting site unless it is inspected and cleared by a competent engineer/supervisor.

(n) Explosives and blasting material should be stored only in clean, dry, well-ventilated, suitably constructed bullet/ magazine which should be fire resistant and securely locked. Stock book should be kept accurate and maintained. Licence should be obtained for storage of explosive as per the Explosives Act, 1884.

(o) Blasting caps, electric blasting caps or primers and detonators should not be stored in the same box, container or room with other explosives.

(p) Precautions against lightening should be provided in accordance with Indian Electricity Rules, 1956 (amended in 2000).

(q) The explosives should be transported in specially designed vehicles bearing a special sign or inscription entitled 'DANGER - EXPLOSIVES'. Also detonators separated from other explosive should be transported in a separate compartment.

4.3 Excavation, Trenching and Earth Removal

(a) Before taking up excavation work, necessary permission should be obtained from the engineer-in-charge with reference to existing underground services.

(b) The engineer-in-charge of the works should exercise full care to ensure that no damage is caused by him or his workmen, during the operation/excavation etc., to the existing water supply, sewerages, power or telecommunication lines or any other services or works. He should provide and erect before construction, substantial barricades, guardrails, and warning signs around the work area. He should also furnish, place and maintain adequate warning lights, display board, signals etc., as required.

(c) All trenches 1.2 m or more in depth should at all times be supplied with at least one ladder for every 30 m along the trench. Ladders shall extend from bottom of the trench to at least 1m above the surface of the ground.

(d) The sides of the trench/pit in soil, which are 1.2 m or more in depth should be stepped back to give suitable slope (angle of repose) or securely held by timber bracing or appropriate shoring/support, to avoid the danger of soil slides from collapsing. The excavated material should not be placed within 1.5 m or half of the depth of the pit whichever is more from edges of the trench/pit. Cutting should be done from top to bottom. Under no circumstances mining or under-cutting should be done.

(e) Workers should not be exposed to the danger of being buried by excavated material or collapse of shoring. Measures to prevent dislodgment of loose or unstable earth, rock or other material from falling into the excavation by proper shoring shall be ensured.

(f) The stability and safety of the excavation, adjacent structures, services and other works should be ensured.

(g) All excavated area should be fenced off by suitable railing and installation of caution board to warn the persons from slipping or/ falling into the excavation pit/ mound.

(h) All excavated areas shall have an illumination level of at least 20 lux for night work and a red danger light shall be displayed at prominent place near the excavation site to warn approaching traffic and men.

(i) For removal of earth from an earth mound/excavated heap a written permission should be obtained from the engineer-in-charge of the work. As far as practical, earth should be removed mechanically. Wherever manual removal of earth is involved, earth should be removed from the top by maintaining a slope equal to the angle of re-pose of the earth. Such work should be constantly supervised to ensure that no under-cutting is done and to ensure that no person is trapped.

(j) Dumping of excavated soil should be done at a specified area under proper supervision with respect to signaling, illumination and safety clearance.

(k) It should be ensured that at a construction site of a building or other construction work, every vehicle or earth moving equipment is equipped with a) silencers, b) tail lights, c) power and hand brakes, d) reversing alarm e) search light for forward and backward movement, which are required for the safe operation of such vehicle or earth moving equipment and f) the cab of the vehicle or earth moving equipment is kept at least one meter from the adjacent face of a ground being excavated. g) indicator etc.

(l) It should be ensured that when a crane or shovel is traveling, the boom of such crane or shovel is in the direction of such travel and the bucket or scoop attached to such crane or shovel is raised and without load, except when it is traveling downhill.

(m) Before loading or unloading power trucks or trailers attached to tractors, the brakes should be applied and if vehicle is on a sloping ground, the wheels should be blocked. Handcart should not be used for the transfer of construction/erection materials in the construction

area. However if the exigency demands urgent transfer of light materials a small handcart may be permitted with the prior approval of the engineer-in-charge.

(n) It should be ensured that at a construction site of a building or other construction work:

(i) All transport or earth moving equipment and vehicles are inspected at least once in a week by responsible persons and in case any defect is noticed in such equipment or vehicle, it is immediately taken out of service.

(ii) Safe gangways are provided for to and fro movement of building workers engaged in loading and unloading of lorries, trucks, trailers and wagons.

(iii) All earth moving equipment, vehicles or other transport equipment be operated only by such persons who are adequately trained and possess such skills as required for safe operation of vehicles or other transport equipment.

(iv) Trucks and other equipment are not loaded beyond their safe carrying capacity, which should be clearly marked on such trucks and other equipment.

(v) No unauthorised person rides the transport equipment employed in such work.

(o) It should be ensured at a construction site of a building or other construction work that:

(i) A shovel or an excavator whether operated by steam or electric or by internal combustion used for such work is constructed, installed, operated, tested and examined as required under any law for the time being in force and the relevant national standards.

(ii) Buckets or grabs of power shovels are propped to restrict the movement of such bucket or grabs while being repaired or while the teeth of such bucket or grabs are being changed.

(p) It should be ensured at a construction site of a building or other construction work that:

(i) An operator of a bulldozer before leaving – applies the brakes, lowers the blade and ripper and puts the shift lever into neutral.

(ii) A bulldozer is parked on level ground at the close of the work.

(iii) The blade of a bulldozer is kept low when such bulldozer is moving uphill.

(iv) Bulldozer blades are not used as brakes except in an emergency.

(q) It should be ensured at a construction site of a building or other construction work that:

(i) A tractor and a scraper are joined safely at the time of its operation

(ii) The scraper bowls are propped while blades of such scraper are being replaced.

(iii) A scraper moving downhill is driven in low gear.

(r) It should be ensured at a construction site of a building or other construction work that:

(i) Before a road roller is used on the ground, such ground is examined for its bearing capacity and general safety, especially at the edges of slopes such as embankments on such grounds.

(ii) A roller is not moved down hill with the engine out of gear.

(s) Vehicle carrying excavated material should have proper cover over the driver's cabin.

4.4 Safe Means of Access/Platforms

(a) Adequate safe means of access and exit should be provided for all work places, at all elevations.

(b) Suitable scaffolds should be provided for workmen for all works that cannot be done safely from the ground, or from solid platform except such short duration work that can be done safely from ladders. Bamboo/wooden scaffolding should not be permitted.

(c) Where the platform for working is more than 3.5 m above ground, the width of the platform should be minimum 1 m.

(d) Ladder should be of rigid construction having sufficient strength for the intended loads. Wooden/bamboo/rope ladders should not be permitted. All ladders should be maintained in good condition. The ladders should be fixed to the ground or rigid platforms. An additional person should be engaged for holding the ladder, if ladder is not securely fixed. Ladder shall be extended from floor to at least one meter above the platform.

(e) A portable ladder should be given an inclination not steeper than 1 in 4 (1 horizontal and 4 vertical). Ladders should not be used for climbing while carrying materials in hands. While climbing both the hands should be free.

(f) Any working platform on scaffolding or staging more than 3.5 m above the ground or floor should have a guard rail attached, bolted, braced at least 1 m high above the floor or platform of such scaffolding or staging along with mid-rail.

(g) The planks used for any working platform should not project beyond the end supports to a distance exceeding four times the thickness of the planks used. The planks should be rigidly fixed at both ends to prevent sliding, slipping or tilting. The thickness of the planks should be adequate to take load of men and materials and should not collapse. Plywood or packing wood should not be used as planks.

(h) The guardrail should extend along the entire exposed length of the scaffolding with only such opening as may be necessary for the delivery of materials. Standard railing should have posts not more than 2 m apart and an intermediate rail halfway between the floor or platform of the scaffolding and the top rail. Such scaffolding or staging should be so fastened as to prevent it from swaying from the building or structure. Scaffolding and ladder should conform to IS 3696 (Part 1): 1987 and (Part II): 1996.

(i) Working platforms of scaffolds should have toe boards at least 15 cm in height to prevent materials from falling down.

(j) A sketch of the scaffolding proposed to be used should be prepared and approval by the engineer-in-charge obtained prior to start of erection of scaffolding. All scaffolds should be examined by engineer-in-charge before use.

(k) Working platform, gangways and stairways should be so constructed that they should not sag unduly or unequally and if the height of the platform or gangway or stairway is more than 3.5 m above ground level or floor level. They should have adequate width for easy movement of persons and materials and should be suitably guarded.

(l) No single portable ladder should be used for access to a height of more than 4.5 m. For ladders up to 3m in length the width between styles (side bars)/width in the ladder should in no case be less than 300 mm. For longer ladders this width should be increased by at least 20 mm for each additional meter of length. Step/rungs spacing should be uniform and should not exceed 300 mm. Portable ladder should be used only for access to work place. In case work place is higher than 4.5 meters, pre-fabricated steel staircase should be used.

4.5 Work at Height

(a) Person to work at height should be medically fit and should have height pass issued by safety section. (Appendix A Part A, B and C). Safety training should be imparted before working at height.

(b) Safety work-permit system for working at height should be obtained from industrial safety section.

(c) At elevated places, secure access and foothold should be provided. Adequate and safe means of access and exit should be provided at all work places for all elevations. Means of access may be portable or fixed ladder, ramp or a stairway. The use of crosses, braces or framework, as a means of access to the working platform should not be permitted.

(d) Linear movement at height should be reduced to minimum. In case of such movement provision for anchoring the safety belt should be made.

(e) Where barricades cannot be installed, a safety net of adequate strength should be installed close to the level at which there is a danger of fall of personnel/fall of objects.

(f) In case where 'work at height' is on asbestos roof, crawling board, roof ladder should be used to walk across the asbestos roof.

4.6 Electrical Safety

(a) All electrical installations shall comply with the appropriate statutory requirements given below and shall be subject to approval of the electrical engineer and safety officer.

(i) The Electricity Act, 2003

(ii) The Indian Electricity Rules 1956 (as amended in 2000)

(iii) The National Electricity Code 2008

(iv) Atomic Energy (Factories) Rules, 1996

(v) Other relevant rules of statutory bodies and power supply authority

(vi) Relevant standards of BIS

In addition to the above statutory provisions, the clauses indicated in this document shall also be complied.

(b) It shall be the responsibility of the user seeking temporary power supply to indicate in writing, if any of the clauses (requirements noted in above regulations and in this document) are conflicting with each other and for which the user cannot decide the course of action regarding safe installation, commissioning, operation, maintenance and decommissioning of the electrical installations.

(c) The electrical engineer and safety officer of the facility providing temporary power supply shall interpret the concerned conflicting clauses and approve in writing the safe course of action.

(d) The Application Form-1 (Form-1A, 1B and 1C) as mentioned in Appendix-B should be submitted by the user for getting the temporary power supply.

(e) After installation of temporary electrical panels, wiring works by the user, certificates as per Form-1D (Appendix-B) should be submitted to the provider.

(f) Certificate of safety officer and authorisation of electrical engineer for energisation of temporary power supply should be filled as per Form-1E (Appendix-B).

4.7 Material Handling and Lifting Machines and Tackles

(a) It should be made compulsory to supervise jobs like lifting/placing/loading/unloading/carrying/transporting etc. of heavy material by qualified supervisor having knowledge about hazards involved and precautions to be taken for such job.

(b) The line managers should ensure that the material handling equipment used is adequate to handle the load.

(c) Manual pulling of heavy equipment and trolley loaded with heavy material is not to be permitted.

(d) Stacking and handling of heavy materials should be done on a firm ground to prevent settlement.

(e) No lifting machine and no chain, rope or lifting tackle, except a fiber rope or fiber rope sling, shall be taken into use in any factory for the first time in that factory unless it has been tested and all parts have been thoroughly examined by a competent person. A certificate of such a test and examination specifying the safe working load or loads and signed by the person making the test and the examination has been obtained and is kept available for inspection.

(f) Use of lifting machines and tackles should conform to relevant BIS requirements [IS 13367 (Part 1): 1992 Reaffirmed 2003, IS 4573: 1982 (Reaffirmed 2000) and IS 13834 (Part 1): 1994 Reaffirmed 2003 etc. The accessories and the attachments, anchorages and supports etc. should be ensured in healthy conditions by regular inspections at defined frequencies.

(g) Every rope used in hoisting or lowering materials or as a means of suspension should be of good quality and adequate strength and free

from any defect. This should be ensured by regular inspection as per IS 2762: 1982- Specification for wire rope slings and sling legs (first revision).

(h) Every crane operator or lifting appliance operator should be authorised. No person under the age of 18 years should be in charge of any hoisting machine or give signal to an operator of such machine.

(i) In case of every lifting machine (and of every chain, ring, hook, shackle, swivel and pulley block used in hoisting or as a means of suspension) the safe working load should be ascertained and clearly marked. In case of a lifting machine having a variable safe working load, each safe working load and the conditions under which it is applicable should be clearly indicated. No part of any machine should be loaded beyond the safe working load except for the purpose of testing. This should be approved by the engineer-in-charge and head, industrial safety.

(j) In case of facilities machines, the safe working load should be notified by the engineer-in-charge. As regards the contractor's machines, the contractor should declare the safe working load of the machine to the engineer-in-charge whenever he brings any machinery to site of work and get it verified by the engineer-in-charge, supported by a valid test certificate by the competent person.

(k) Thorough inspection and load testing of lifting machines and tackles should be done in the presence of competent person at least once in every 12 months and records of such inspections and testing should be maintained.

(l) No mobile crane should be allowed to move under live high-tension power transmission line.

(m) While lifting loads, cranes should be located on level ground.

(n) A thorough load analysis should be carried out before using cranes in tandem.

(o) Motors, gear transmission, couplings, belts, chain drives and other moving parts of hoisting appliances should be provided with adequate safeguards. Hoisting appliances should be provided with such means, which will reduce the risk of any part of a suspended load becoming accidentally displaced or lowered.

(p) It should be ensured that the cabin of the lifting machine in outdoor service:

(i) is made of fire resistant material,

(ii) has a suitable seat, a footrest and protection from vibration,

(iii) affords the operator an adequate view of the area of operation,

(iv) affords the operator adequate protection against the weather, and

(v) is provided with fire extinguisher.

4.8 Welding and Gas Cutting

(a) Welding and gas cutting operations should be done by qualified and authorized persons only.

(b) Safety work permit should be obtained (wherever necessary like presence of flammable or combustible material etc.) before flame cutting/welding is taken up.

(c) Welding and gas cutting should not be carried out in places where flammable or combustible materials are kept and where there is danger of explosion due to presence of gaseous mixtures. In case the requirement cannot be avoided, specific approval and procedure should be ensured and adequate precautions should be taken.

(d) Welding and gas cutting equipment including hoses and cables should be maintained in good condition.

(e) Barriers should be erected to protect other persons from harmful rays from the work. When welding or gas cutting is done in elevated positions, precautions should be taken to prevent sparks or hot metal falling below on persons or combustible materials.

(f) Suitable type of protective clothing consisting of fire resistant gauntlet gloves, leggings, boots and aprons should be provided to workers as protection from heat and hot metal splashes. Face shields with filter glasses of appropriate shade should be worn.

(g) Adequate ventilation should be provided while welding, brazing and cutting the metals like zinc, brass, bronze, galvanised or lead coated material.

(h) Welding and gas cutting on drums, barrels, tanks or other containers should be taken up only after ascertaining that they have been emptied, cleaned thoroughly and made free of flammable material.

(i) Fire safety measures should be available as required near the location of welding/cutting operations.

(j) Flash back arrestor should be provided with gas cutting and gas welding sets.

(k) For electric (Arc) welding the following additional safety precautions should be taken:

(i) When electrical welding is undertaken the return lead of welding machine should be directly connected to the job invariably.

(ii) Provision must be in place in electric welding machine to prevent physical contact with live parts.

(iii) The welding cables and power cables should be routed separately to avoid entanglement.

(iv) The electric welding set should have suitable earth connections. There should be an electrical isolation device in the input power supply side on the welding machine.

(l) Double gauges should be used for all gas cylinders used for cutting/ welding. Pressure gauges/regulators should be in healthy condition.

4.9 Rotary Cutters/Grinders

(a) All portable cutter/grinders should be provided with the wheel guard in position.

(b) Grinding wheels of specified diameter only should be used on all grinders in order to limit the prescribed peripheral speed.

(c) In pedestal grinder, the gap between tool rest and grinding wheel should be maintained less than 3 mm.

(d) Goggle/face shield should be used during grinding operation.

(e) No grinding wheel should be used after its expiry date.

(f) Ear muff/ear plug should be used during the welding/cutting jobs.

(g) Portable appliances, which are powered by single phase AC supply, shall be provided with three-core cable and three pin plug, otherwise the whole body should be double insulated.

(h) Safety work permit should be obtained (wherever necessary like presence of flammable or combustible material etc.) before grinding is taken up.

(i) Fire safety measures should be available as required near the location of grinding operations.

4.10 Concrete Mixing Equipment

(a) Cement bags should be stacked on wooden planks in dry and leak proof area, 150 mm to 200 mm from the floor and 450 mm away

from walls. Height of the stack should not be more than 15 bags or 1.5 meters which ever is lower. Width of the stack should not be more than 4 bags or 3 meters. Lateral loading of the walls of the storage room by stacking should not be permitted. Stacking of the bags should not be used as a working platform.

(b) Shuttering and supporting structures should be of adequate strength and approved by engineer-in-charge. This should be ensured before concrete is poured.

(c) If the mixer has a charging skip the operator should ensure that the workmen are out of danger before the skip is lowered.

(d) Adequate walking platforms (as per the AERB directives) are to be provided in the reinforcement area to ensure safe walking for pouring concrete on the roof.

(e) When workmen are working/cleaning the inside of the drum of mixer, the power of the mixer should be switched off and "Do not operate" tag should be provided. The plant operation and cleaning of mixing pan should be carried out as per equipment supplier's instructions.

(f) Interlocks between the cover and the mixer rotor shall be established to ensure that the agitator does not start when the cover is in open condition.

(g) It should be ensured that moving parts of the elevators, hoists, screens, bunkers, chutes and grouting equipment used for concrete work and of other equipment used for storing and transporting of ingredients of concrete are securely fenced to avoid contact of workers with such moving parts.

(h) It should be ensured that screw conveyors used for cement, lime and other dusty material are completely enclosed.

(i) Workers engaged for handling bulk cement in a confined place should be provided with tight fitting goggle, approved respirators and protective clothing, which will fit snugly around the neck, wrist and ankles.

(j) The following should be ensured for every pipe carrying pumped concrete:

    (i) The scaffolding carrying a pipe for pumped concrete should be strong enough to support such pipe at a time when such pipe is filled with concrete or water or any other liquid and to bear safely all the building workers who may be on such scaffold at such time.

(ii) Securely anchored at its end point and each curve on it.

(iii) Provided with an air release valve near the top of such pipe; and securely attached to a pump nozzle by a bolted collar or other adequate means.

(k) The following should be ensured while using the electric vibrators in concreting work at a construction site of a building or other construction work such that:

(i) Such vibrators are earthed.

(ii) The leads of such vibrators are heavily insulated.

(iii) The current is switched off when such vibrators are not in use.

(l) For obtaining a clearance for first pour of concrete and regular operation of ready mix concrete (RMC) plant, checklist given in Appendix-C shall be submitted to AERB along with the application for clearance.

4.11 Painting

(a) Appropriate breathing air respirators should be provided for use by the workers when paint is applied in the form of spray, or a surface having lead paint is dry rubbed or scraped.

(b) Only the quantity of paint, thinner and polish required for the day's work should be kept at the work spot. Excess storage should not be permitted at the work spot.

(c) Smoking, open flames or sources of ignition should not be allowed in places where paints, varnish, thinner and other flammable substances are stored, mixed or used. A caution board, with the instructions written in national language and regional language, 'SMOKING - STRICTLY PROHIBITED' should be displayed in the vicinity where painting is in progress or where paints are stored. Symbols should also be used on caution boards.

(d) All electrical equipment of paint storage room should be of explosion proof design. Suitable fire extinguishers/sand buckets should be kept available at places where flammable paints are stored, handled or used.

(e) When painting work/hot resin mix is done in a closed room or in a confined space, adequate ventilation should be provided and ensured. In addition, suitable respirators should be provided. No portable electric light or any other electric appliance of voltage exceeding

24 volts should be permitted for use inside any confined space. Walkie-talkie or other means of communication should be provided. Rescue arrangement like full body harness with lifeline, tripod with pulley and extra BA sets should be available.

(f) The workers should use PVC gloves and/or suitable barrier creams to prevent the skin contact with Epoxy resins and their formulations used for painting.

4.12 Demolition

(a) Before any demolition work is commenced and also during the progress of the work, all roads and open area adjacent to the work site should either be closed or suitably cordoned. Appropriate warning signs should be displayed for cautioning approaching persons/ vehicles.

(b) Before demolition operations begin, it should be ensured that all the service lines are de-energized.

(c) Persons handling demolition operations shall use appropriate PPE.

(d) All demolition operations should be carried out with safe and duly approved procedures which shall include following but not limited to:

(i) No masonry/material should be permitted to fall in such masses or volume or weight so as to endanger the structural stability of any floor or structural support.

(ii) No wall, chimney or other structure or part of a structure is left unguarded in such a condition that it may fall, collapse or weaken due to wind pressure or vibration.

(iii) No floor, roof or other part of the building should be overloaded with debris or materials as to render it unsafe.

(e) After the demolition, the debris and other materials collected should be disposed safely and not permitted to be dropped freely.

(f) Entries to the demolition area shall be restricted to authorised persons wearing safety helmets and safety shoes.

4.13 Traffic

(a) All the vehicles moving at sites should conform and comply with the requirements of Motor Vehicles Act, 1988 and the Rules made there under. All the drivers/operators of vehicles should possess valid driving license as per Motor Vehicles Act, 1988 or its latest amendment.

(b) The facility should conduct operations so as to interfere as little as possible with the use of existing roads at or near locations where the work is being performed. When interference to traffic is inevitable such as road cutting or transit unloading of heavy equipment etc. notice of such interference should be given to the engineer-in-charge and safety officer well in advance with the details of start of the work and time required.

(c) A cleaner/assistant must be available for all heavy vehicles whenever vehicles move forward as well as in the reverse direction. All vehicles should be fitted with proper reverse horns, back view mirrors and indicator signals.

(d) Facility should ensure that the assessment of the driver's visual ability is carried out as per Rule 55 of the Atomic Energy (Factories) Rules, 1996/guidelines of advisory committee on occupational health (ACOH), AERB or as per the latest amendments in statutes.

(e) Effective speed breakers with yellow stripes on the roads to regulate the speed at the vulnerable points should be installed. Effective barricading with adequate caution signs should be placed to warn the vehicle drivers whenever the jobs are carried out on the road.

(f) All vehicles moving at the site should have roadworthiness certificate issued by the concerned authority.

(g) Special limit boards and caution boards indicating turns should be installed wherever necessary.

(h) In general, the following maximum speed limits should be specified and implemented. Vehicles speed limits should be as per Motor Vehicle Act or 20 Km/h. Extra precautions and care should be exercised particularly during heavy material/equipment movements.

(i) Safety awareness programmes should be conducted for all the drivers of the light, medium and heavy vehicles.

4.14 Work in Radiation Area

The facility should follow the stipulated procedure under Atomic Energy Radiation Protection Rules, 2004 and AERB safety manual on 'Radiation Protection for Nuclear Facilities' (AERB/NF/SM/O-2) regarding work in the radiation area and other works related with radiography.

4.15 Work in and Around Water Bodies

(a) When work is done at a place where there is risk of drowning, all necessary rescue equipment such as life buoys and life jackets should be provided and kept ready for use.

(b) All necessary steps shall be taken for prompt rescue of any person in danger and adequate provision should be made for prompt first-aid treatment of all injuries likely to be sustained during the course of the work. Proper record of entry/exit to and from water bodies shall be maintained on shift basis and search operation shall be conducted as soon as any person is detected to be missing.

(c) Caisson Work

(i) Safe means of access should be provided to the place of work in the caisson and adequate means should be provided to safely reach the top of caisson in the event of inrush of water

(ii) The work relating to construction, positioning, modification or dismantling of caisson shall be done under the supervision of a responsible person

4.16 Fire Safety

(a) All provisions for fire safety shall be complied as per AERB safety standard on 'Fire Protection Systems for Nuclear Facilities' [AERB/NF/SS/FPS (Rev. 1)].

(b) All necessary precautions should be taken to prevent outbreak of fires at the construction site. It should be ensured that all hot work is carried out under valid work permit.

(c) Combustible materials such as wood, cotton waste, oil, coal, paints, chemicals etc., should be segregated and kept to the required bare minimum quantity at work place.

(d) Containers of paints, thinners and allied materials should be stored in a separate room which should be well ventilated and free from excessive heat, sparks, flame or direct rays of the sun. The containers of paint should be kept covered or properly fitted with lid and should not be kept open except while using.

(e) Adequate number of trained persons from approved fire training centre required to extend fire safety coverage should be ensured.

(f) Fire extinguishers as approved by the engineer-in-charge/in-charge of fire station/safety-in-charge should be located at the construction site at appropriate places.

(g) Adequate number of trained workmen in fire fighting who can operate fire extinguishers should be ensured.

(h) Portable fire extinguishers with periodic inspection, maintenance and re-filling complying with the mandatory requirements should be ensured.

(i) Availability of adequate water for fire fighting should be ensured.

(j) Implementation of the provisions of various statutory licenses for storing gas cylinders, petroleum products, explosives etc. as per the relevant acts and rules should be ensured wherever required.

4.17 Environmental Safety

Relevant provisions of the state/central statutory authority regarding environment protection should be adhered to.

4.18 Public Protection

The Facility should make necessary provisions to protect the public. He should be bound to bear the expenses in defense of every action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of any precaution required to be taken to protect the public. He should pay for the any such damage and cost which may be awarded in any such suit, action or proceedings to any such person, or the amount, which may be fixed as a compromise by any such person.

4.19 Safety of Visitors

(a) Visitors for the project shall be given health and safety induction before they are allowed in to the construction project. It shall include the minimum PPE to be used, hazards and risks at the work area, restricted areas of entry, emergency response arrangements, etc.

(b) Visitors shall always be accompanied by one of the employees of the project site.

(c) Visitors shall not be allowed in the hazardous areas unless they are competent and trained to work in such areas.

4.20 Housekeeping

(a) It should be recognised that a proper place for everything and everything in its place is maintained for a good housekeeping.

(b) The material required for immediate use only should be brought to the designated workplace and stacked properly and labeled suitably.

(c) All work spots, site office and surroundings should all times be kept clean and free from debris, scrap, concrete muck, surplus materials and unwanted tools and equipment. A day-to-day collection and disposal of scraps/debris should be done safely at designated place.

(d) Electrical cables, leads and hoses should be so routed as to allow safe traffic by all concerned. Cable should be preferably supported on the brackets fixed along the wall to maintain safe access. Wherever

routing on the floor cannot be avoided, care should be taken to ensure mechanical protection of these cables and safe access is not disturbed.

(e) No material on any work place should be so stacked or placed or disposed off as to cause danger, inconvenience or damage to any person or environment.

(f) All unused scaffoldings, surplus/scrap materials and equipment/ systems like temporary electrical panels etc. should not be allowed to accumulate and shall be removed from the premises at the earliest.

(g) Accumulation of water/oil spillages on the floor or any other workplace should be avoided.

(h) Proper aisle space marking should be provided in all workplaces.

4.21 Other Statutory Provisions

Notwithstanding the clauses in the above subsections, there is nothing in these clauses to exempt the Facility from the provisions of any other act or rules in force in the Republic of India. In particular, all operations involving the transport, handling, storage and use of explosives should be as per the standing instructions and conform to the Indian Explosives Act, 1884 and the Explosives Rules, 1983. Handling, transport, storage and use of compressed gas cylinders and pressure vessels should conform to the Gas Cylinder Rules 2004 and Static and Mobile Pressure Vessels (Unfired) Rules 1981. In addition, The Indian Electricity Act 2003 and Indian Electricity Rules 2005, the Atomic Energy Act, 1962, the Radiation Protection Rules, 2004, the Atomic Energy (Factories) Rules, 1996 and AERB safety manual on 'Radiation Protection for Nuclear Facilities' (AERB/NF/SM/O-2) should be complied with.

5. PERSONAL PROTECTIVE EQUIPMENT

5.1 General

Although the primary approach in any safety effort is that the hazard to the workmen should be eliminated or controlled by engineering methods rather than protecting the workman through use of personal protective equipment (PPE). Engineering methods could include design change, substitution, ventilation, mechanical handling, atomisation etc. Under those situations when it is not possible to introduce any effective engineering methods for controlling hazards, it is necessary that workman use appropriate type of PPE. For example, in construction work there is the possibility of a hand tool, a bolt, or some loose material to fall from an elevated level and striking the head of workman working below. It is therefore necessary that construction worker wear a safety helmet. It is for such situations, both the Factories Act 1948 and the Atomic Energy (Factories) Rules, 1996 have provisions for use of appropriate type of PPE.

It is thus recognised that use of PPE is an important and necessary consideration in the development of a safety programme. Once the safety professional decides that PPE is to be used by workmen, it is essential to select right type of PPE and management should ensure that workman uses it and also PPE is correctly maintained.

5.2 Personal Protective Equipment (PPE)

(a) All personal protective equipment as considered necessary should be made available for the use of the persons employed on the site and maintained in a condition suitable for immediate use. Also adequate steps should be taken by engineer-in-charge to ensure proper use of PPE.

(b) All the PPEs in use should be as per relevant IS standards as referred in the AERB safety guidelines on 'Personal Protective Equipment' (AERB/SG/IS-3).

(c) All persons employed at the construction site should use safety helmets. Safety helmet should be with BIS mark and should have its headband with back support and chin strap.

(d) Workers employed on mixing asphaltic materials, cement and lime mortars should use protective goggles, protective foot wears, hand gloves and respirators as required.

(e) Persons engaged in welding and gas-cutting works should use suitable welding face shields. The persons who assist the welders should use suitable goggles. Protective goggles should be worn while chipping and grinding.

(f) Stonebreakers should use protective goggles. They should be seated at sufficiently safe distances from one another.

(g) Safety goggles should be of shatterproof type and with zero power.

(h) Persons engaged in or assisting in shot blasting operations and cleaning the blasting chamber should use suitable gauntlets, overalls, shatterproof and dust-proof goggles and self contained breathing apparatus set.

(i) All persons working at heights more than 3.5 m above ground or floor and exposed to risk of falling down should use full body harness safety belts, unless otherwise protected by cages, guard railings, etc. In places where the use of safety belts is not feasible, suitable net of adequate strength fastened to substantial supports should be used.

(j) When workers are employed in sewers and inside manholes that are in use, it should be ensured that the manholes are opened and are adequately ventilated at least for an hour. After it has been well ventilated, the atmosphere inside the space should be checked for the presence of any toxic gas or oxygen deficiency by a competent person and recorded in the register before the workers are allowed to get into the manholes. A pilot team should enter the area donning self contained breathing apparatus (SCBA). The manholes opened should be cordoned off with suitable railing and provided with warning signals or caution boards to prevent accidents. There should be proper illumination in the night. Depending upon the work situation, the facility should provide PPE including the SCBA as recommended by Head, industrial safety.

6. MEDICAL MANAGEMENT

6.1 General

(a) The facility management/contractor shall make arrangements for the first aid and medical services for the injured or ill persons for prompt attention or aid.

(b) The arrangement can be made by the contractor or an agreement can be in vogue with the facility .

(c) The medical facilities at first-aid centre shall be adequate to immediately cater to the injured based on the hazard potential and probable severe injuries.

(d) The first aid centre shall be provided with the adequate equipment and medicines for catering to the site requirements. The first aid centre shall be manned depending on the working hours/on round the clock shift basis. The services of at least one qualified medical practitioner (medical officer) shall be made available by the Facility management/contractor.

6.2 Medical Facilities

(a) Medical facilities conforming to the provisions of the Atomic Energy (Factories) Rules, 1996 should be provided at all work sites.

(b) The requisite medical facilities in the form of a well-equipped first aid centre manned by qualified nursing personnel should be provided at all work sites. Contractor may avail this facility as per terms and conditions of the contract.

(c) In addition, well-maintained first aid boxes should be kept at each location of the work by the Facility/contractor and availability of the personnel trained in first aid should be ensured.

(d) A manned and equipped ambulance should be available at work site during the working hours/on round-the-clock shift basis.

(e) It should be ensured by the occupier that occupational health monitoring of contract workers is carried out as per provisions of the Factories Act 1948 as per the latest amendment and the stipulations/directions given by Atomic Energy Regulatory Board from time to time.

(f) Display of emergency contact numbers of important persons and hospitals and route map of site shall be maintained at designated places.

6.3 Medical Management of Serious Injuries

(a) In case of serious injuries, the injured should be shifted to the nearest first-aid centre at site immediately. The opinion of medical officer/ certifying surgeon should be sought immediately for medical management.

(b) After providing the first aid treatment the injured should be shifted to designated medical facility of the site/hospital for further medical assistance, in an ambulance along with a nursing attendant.

(c) The doctor at the medical facility of the site/hospital attending the case shall assess the extent of injuries and render immediate medical aid. If the situation warrants trauma/special care the injured shall be shifted to the referral hospital, having all the requisite facilities for specialised treatment in ambulance along with a medical attendant.

(d) A list of such referral hospitals for specialised medical management facilities for the injured persons should be available with the project management/Head, industrial safety and Head, medical services of the site for ready reference.

APPENDIX-A

APPLICATION FOR HEIGHT PASS

PART- A

Group/Section: _____

Agency: _____

1. Applicant's Name : _____
2. Facility address : _____
3. Residential address : _____
4. Age : _____
5. Sex : _____
6. Height : _____
7. Gate Pass No. : _____
8. Name of contractor/agency with whom engaged at present : _____
9. Height pass required for work at _____ m. Height
10. Description of present job : _____
11. Previous experience of working at height :

S.No.	Name of the Employer	Duration of Employment	Work Experience
1.			
2.			

12. Does the applicant suffer from any of the following ailments? (If yes details to be given):

    (a) Blood pressure _____ (b) Epilepsy _____

    (c) Flat foot _____

    (d) Frequent headache or reeling sensation _____

    (e) Mental depression _____ (f) Limping gait _____

    (g) Aerofobia _____

Declaration:

I hereby declare that the above information furnished by me is true and correct. I shall always wear the safety belt and tie the life-line whenever working at unguarded heights of 3 m and above. I shall not misuse the height pass issued to me or transfer it to any other person. I shall never come to duty or work at height/depth under the influence of alcohol/drugs.

Date: Name:

Sign:

(Applicants name and signature or loss time injury (L.T.I) incase he cannot sign. In case of LTI an authorised person shall explain each point/item to the individual and certify on that behalf below the LTI)

I certify that I am satisfied with the above certification of the individual for the application of height pass and request for issue of height pass to him.

Name :

Sign :
(Agency Concerned)

Countersigned by:

Section Head (Facility)

PART- B

MEDICAL FITNESS CERTIFICATE

Certified that I, Dr. _____ have examined Shri _____ _____ aged _____ on (date) _____ who has signed below in my presence. General & physical examinations of Shri. _____ _____ do not reveal any abnormality. He does not suffer from any acute/ chronic skin disease or any contagious or infectious disease. His eye sight is normal with/without glasses. In my opinion, Shri _____ is physically and mentally fit for working at height.

Details of examinations are given below:

Personal attributes:

1. Height: _____
2. Chest: _____
3. Weight: _____
4. Hearing: _____
5. Sight: _____
6. Skin: _____
7. Heart beating: _____

Medical aspects:

1. Urine: _____
2. Blood pressure: _____
3. Epilepsy: _____
4. Flat foot: _____
5. Frequent headache or reeling sensation: _____
6. Mental depression: _____
7. Limping gait: _____
8. Aerophobia: _____

Name:

Sign :

Rubber Stamp of
Medical Practitioner
with Reg. No.

Signature of workman:

PART-C

INDUSTRIAL SAFETY SECTION

(Considering the above medical certificate, the applicant has appeared on the following practical tests conducted by industrial safety section and the results are given below (strike off whichever is in-applicable)

(a) Wearing a safety belt and tying the rope knot : Pass/fail

(b) Walking over a horizontal structure at 3 m. height wearing a safety belt : Pass/fail

(c) General physique (OK/Not OK)

The above applicant's performance in the above tests has been satisfactory/ unsatisfactory due to the following.

So I certify and issue this height pass to Shri _____ with Registration No. _____ in the height pass register. This is valid for one year from the date of issue i.e. up to _____

Date:

Name:

Sign.:
Scientific Assistant (Safety)

Safety Officer

APPENDIX-B

FORM - 1

APPLICATION FOR TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION

[Prescribed under clause 4.6(d)]

1.	Name and address of user.	
2.	Reference of tender or work order (if applicable)	:
3.	Name & designation of tender/work order issuing authority.	:
4.	Power supply application number†	:
5.	Name and designation of tender/work order/work supervising authority (engineer-in-charge).	:
6.	Expected date of commencement of temporary supply	:
7.	Expected date of decommissioning of temporary supply	:
8.	Voltage level (LV/MV/HV)	
9.	Type of connection (1Ph/3Ph)	
10.	Connected load (Kw)	
11.	Maximum demand (KVA)/Power factor	
12.	Single line diagram* of proposed power distribution scheme along with equipment data sheet (downstream installation after point of connection).	Enclosed (Form-1A)/Not enclosed
13.	Name of overall supervisor and available qualified Staff	Enclosed (Form-1B)/Not enclosed
14.	Auxiliary equipment data sheet (meters, fire extinguisher, first aid box etc)	Enclosed (Form-1C/Not enclosed
15.	Name and designation of provider's representative to whom the application is addressed.	:
16.	Name and designation of authorized signatory of user, who had submitted this application	:

† Power supply application number shall be different for same user with multiple applications for temporary supply

* All the drawings and tables shall be signed by user's representative indicated against 16 above.

Signature of authorised signatory of user

Signed endorsement of work order supervising authority indicated against 5 above.

FORM - 1A

EQUIPMENT DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION

(Prescribed against item-12 of form-1)

Name and address of user:

Power supply application Number:

Amendment No:-

References:- Single line diagram (SLD) of the power distribution scheme with all equipment details (Attach the SLD)

1. Identity	2. Type	3. Make & model	4. Manufacturer's S.No	5. Fixed/ Portable	6. Size	7. Last used date	8. Last test date	9. Latest test data	10. Rating

Signature of authorised signatory of user

Explanation of column headers:

1. Identity:- Identification mark/number/tag of equipment in single line drawing and layout drawing. Every equipment in single line drawing and layout drawing shall have suitable identification mark/number/tag.
2. Type:- Cable/CB/MCB/MCCB/ELCB/transformer/lightning arrestor/earthing station/ earthing connection/motor/lighting fixture/switch/fuse/switch, socket box etc.
3. Make and model:- manufacturer's name and corresponding model no.
4. Manufacturer's S. No:- serial number and date in name plate if available. Else NA
5. Fixed/portable:- Equipment is installed/laid/anchored to surface or portable.
6. Size:- depending upon type of equipment and as desired by provider representative e.g. length for cables or all dimensions if heavy equipment like transformer.
7. Last used date. date of last use else NEW
8. Last test date. latest test date by user or by manufacturer if NEW
9. Latest test data:- IR, HV, resistance, functional test data depending upon the type of equipment as desired by provider's representative.
10. Rating:- name plate rating of equipment like voltage, current, power (apparent, active, reactive), IP of enclosure, size(cable cross section) etc. depending upon the type of equipment and as desired by provider's representative.

FORM - 1B

STAFF DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION
(Prescribed against item-13 of form-1)

Name and address of user:

Power supply application Number:
Amendment No:-

1. Name	2. Address	3. Tel.No.	4. Responsibility	5. Certification detail	6. Resucitation training	7. Expe-rience	8. Other relevant training	9. Signature

Signature of authorised signatory of user

Explanation of column headers:

1. Name:- Name of agency/person
2. Address:-
3. Tel No:- regular, alternate and emergency telephone numbers
4. Responsibility:- whether responsible for installation, operation, maintenance, overall supervision etc. overall supervisor shall be indicated specifically.
5. Certification detail:- (a) type of certification e.g wire man license, electrical supervisor license, electrical contractor license, diploma in electrical engineering, degree in electrical engineering etc. (b) certifying agency e.g. state PWD, central PWD, CEA, name of college/university etc. (c) certificate/license number with date. (d) valid up to date or next renewal date must for contractor/supervisor license.
6. Artificial resuscitation training:- indicate YES/NO if the staff is trained to apply artificial resuscitation technique.
7. Experience.:- number of years of experience.
8. Other relevant training :- any other training in electrical/safety course. Indicate name of training, duration (days/months), training providing agency.
9. Signature:- original signature of individual.

FORM - 1C

AUXILIARY EQUIPMENT DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION
(Prescribed against item-14 of form-1)

Name and address of user:

Power supply application Number:
Amendment No:-

Reference:- Layout drawing No. / _____

1. Identity	2. Type	3. Make and model	4. Manufacturer's S. No	5. Fixed/ Portable	6. Size	7. Last used date

Signature of user's representative

Explanation of column headers:

1. Identity:- identification mark/number/tag of equipment in layout drawing.
2. Type:- earthing rod/megger/multi meter/earth resistance meter/fire extinguisher/s and bucket/first aid box/resuscitation chart/rubber mat etc.
3. Make and model:- manufacturer's name and corresponding model no.
4. Manufacturer's S. No:- serial number and date in name plate if available. Else NA
5. Fixed/portable:- equipment is installed/laid/anchored to surface or portable.
6. Size:- depending upon type of equipment and as desired by provider representative.
7. Last used date. NEW for new equipment. NA for passive devices like chart/mat etc.

FORM-1D

[Prescribed under clause 4.6(e)]

Name of user agency **Power supply application number:-**

CERTIFICATE BY THE LICENSED ELECTRICAL CONTRACTOR

Certified that subject installations have been carried out by us or checked by us and is in accordance with I.E. Rules. The documents submitted with subject temporary power supply application (Form-1) is verified by us and the complete installation confirms to these documents.

We shall periodically inspect/check the installation so that no unsafe situation arises during use of this temporary power supply system. We understand that for the entire duration of existence of this temporary power supply system we shall be responsible for any unsafe installation, operation, maintenance, testing of the same which results into any loss of life or material. We shall immediately report to the provider's representative and ensure de-energisation of supply if any unsafe situation arises during use of this temporary power supply system.

Signature of the authorised signatory of licensed electrical contractor

Rubber seal of licensed electrical contractor

Date

CERTIFICATE BY THE USER

Certified that my/our installations have been carried out in accordance with the I.E. Rules and that I/We have employed competent agency/staff to handle the installations which is strictly as per the staff data sheet submitted in Form-1B.

We understand that for the entire duration of existence of this temporary power supply system we shall be responsible for any unsafe installation, operation, maintenance, testing of the same which results into any loss of life or material. We shall immediately report to the provider's representative and ensure de-energisation of supply if any unsafe situation arises during use of this temporary power supply system.

Signature of the authorised signatory of user

Name of signatory

Date

FORM -1E

[Prescribed under clause 4.6(f)]

CERTIFICATE BY THE SAFETY OFFICER

Certified that I have inspected the electrical installation referred here in after satisfying myself about the safe condition of the installation, I hereby recommend that the service connection be given to the contractor.

Signature of the safety officer

Name:

Date:

AUTHORISATION BY THE ELECTRICAL ENGINEER

The subject power supply application along with completed installation, necessary certificates (as per Form-1 of Appendix-B) is scrutinised by us. The proposal found to be in order and the installation can be energised on _____ in presence of your designated overall supervisor as indicated in Form-1B. Enclosed herewith the test report data sheet Form-1F. You are requested to carry out the periodic testing of equipment and submit the test report periodically as per this form.

Signature of the electrical engineer
of provider

Name of signatory

Date

FORM - 1F

TEST/MAINTENANCE REPORT DATA SHEET OF EQUIPMENTS OF TEMPORARY POWER SUPPLY SYSTEM AT WORK SITE DURING CONSTRUCTION
(Prescribed against form-1E)

Name and address of user:

Power supply application Number:
Amendment No:-

1. Identity	2. Type	3. Last tested date	4. Next due date of any test	5 Frequency of IR test	6 Frequency of HV test	7. Frequency of earth resistance test	8. Other tests

Signature of electrical engineer of provider

Explanation of column headers:

1. Identity:- identification mark/number/tag of equipment in single line drawing and layout drawing. Every equipment in single line drawing and layout drawing shall have suitable identification mark/number/tag.
2. Type:- Cable/ CB/ MCB/ MCCB/ ELCB/transformer/lightning arrestor/earthing station/ earthing connection/motor/lighting fixture/switch/fuse/switch, socket box etc.
3. Last test date: - latest test date indicated in Form-1A.
4. Next due date of any test:- as worked out by frequency of tests indicated in subsequent columns.
5. Frequency of IR test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
6. Frequency of HV test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
7. Frequency of earth resistance test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
8. Other tests: - name and description of any other essential tests/maintenance activity and required frequency depending upon type of equipment and location of installation. NA if not required after installation.

APPENDIX-C

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

(To be submitted to AERB along with application for construction consent and a copy to be retained by site)

(Verifiable documents like supplementary checklists, work sheets, spread sheets etc. should be maintained for each item of the checklist wherever relevant)

Serial No.	Points to be Checked	Remarks
1. 0	**Prior to Installation of the RMC Plant**	
1.1	Whether acceptance report on healthiness of the pre-identified critical plant equipment like concrete mixer, pumps, programmable logic controllers, conveyors, etc. prior to installation available ?	
1.2	Whether approval for the location of the plant site after evaluation and review by project management available ?	
1.3	Whether review of the vendor documents like operation and maintenance manual, vendor specifications, safety manual, etc. of contractor carried out by project management ?	
1.4	Whether job hazard analysis reports, erection procedures, checklists for critical activities available ? Are the operators aware of it ?	
1.5	Whether adequate number of line managers/supervisors/ operators for carrying out the jobs safely are identified and availability is ensured ?	
1.6	Whether safety surveillance requirements of construction activities both by contractor and facilities clearly spelt out?	
1.7	Whether adequate work control measures like construction permit, safety work permit system, height pass system, etc. for safe job performance are available ?	
1.8	Whether any facilities officer is assigned the responsibility of the RMC Plant ?	
2.0	**Commissioning/Operation of RMC Plant**	
2.1	Whether reports on healthiness of material handling equipment like hoists, belt conveyors, buckets, hoses, including electrical equipment etc. are available ?	

APPENDIX-C (CONTD.)

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

Serial No.	Points to be Checked	Remarks
2.2	Whether machine guards for pulleys, power shafts, rollers, etc. are available ?	
2.3	Whether availability of safe operating procedures, emergency procedures, process diagrams, power supply diagrams, details of interlocks, operation & maintenance manual (provided by supplier/vendor) ensured ?	
2.4	Whether adequate number of qualified, trained and experienced operators for safe operation of the plant including mechanism/method of operational control and command available ?	
2.5	Whether periodic surveillance programme for equipment, logics, interlocks, process parameters, trips, noise and illumination levels, etc. and measures to take corrective actions are available ?	
2.6	Whether periodic checks are carried out to ensure display of all interlocks and warning signals in PLC monitor ?	
2.7	Whether operations control measures like log sheets, work permits, procedures, instruction sheets, by-passing/jumpering trips, etc. are available ?	
2.8	Whether access to medical first-aid box & fire extinguishers, etc. available ?	
3.0	**Operating/Working Areas**	
3.1	Control Room	
3.1.1	Whether adequate information on process equipment and parameters, logics and control available ?	
3.1.2	Whether clear view of the plant from the control room to check entry of personnel into operating areas is available ?	
3.1.3	Whether availability of distinct window panels to distinguish process parameters, alarms and trips are verified ?	
3.1.4	Whether audio alarm is available in the field to give warning prior to starting of concrete mixer & conveyor belt ?	
3.1.5	Whether relevant operating and maintenance documents available and accessible ?	

APPENDIX-C (CONTD.)

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

Serial No.	Points to be Checked	Remarks
3.1.6	Whether operational controls preventing re-setting of operational parameters, trips by-passing, logic changes, etc. are available in control room ?	
3.1.7	Whether operational data and information logged chronologically indicating the status of equipment running & shutdown, maintenance works planned and taken up.	
3.1.8	Whether means of communication between operator and control room are available ?	
3.2	**Aggregates Storage/Handling Areas**	
3.2.1	Whether aggregates/materials stored separately in suitable weatherproof enclosures ?	
3.2.2	Whether routes for movement of vehicles clearly defined ?	
3.2.3	Whether reverse horns, rear view mirror, etc. on all dumpers/ trailers/trucks are provided ?	
3.2.4	Whether machine guards for rotating/moving/conveying machines available in place ?	
3.2.5	Whether engineered noise control measures available in the crushing areas ?	
3.2.6	Whether usage of ear muffs for ear protection in noisy areas enforced ?	
3.2.7	Whether trip/emergency stop switch/pull cord mechanisms, etc. to the moving/rotating equipment like belt conveyors, crushers etc. are available and healthy ?	
3.2.8	Whether adequate dust control measures in working areas available ?	
3.2.9	Whether adequate illumination is provided in the working areas ?	
3.2.10	Whether safety/warning sign boards available to prevent persons approaching operating crushers/belt conveyors etc ?	
3.3	**Storage Hoppers/Silos**	
3.3.1	Whether suitable access with handrails to reach to the top of hoppers/silos provided ?	

APPENDIX-C (CONTD.)

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

Serial No.	Points to be Checked	Remarks
3.3.2	Whether proper walk ways with guard railing to access to different storage areas available ?	
3.3.3	Whether measures to prevent clogging of equipment like air fluidiser, etc. are available ?	
3.3.4	Whether controls and safety measures for feeders like belt conveyors to the silos/hoppers, etc. is available ?	
3.3.5	Whether dust suppression and noise control measures are in place ?	
3.3.6	Whether safety measures to enter into silos/hoppers for operation/maintenance requirements.	
3.3.7	Whether safe access for sampling locations/areas and procedure for collecting the samples are available ?	
3.4	**Concrete Mixer Areas**	
3.4.1	Whether safe access and working platform in mixing area provided ?	
3.4.2	Whether safe condition of the mixers, pumps, etc. used in the areas is ensured ?	
3.4.3	Whether proper identification tags for equipment, pipelines etc. are available ?	
3.4.4	Whether safe condition of the electrical equipment like local push buttons, panels, cables etc. ensured ?	
3.4.5	Whether adequate illumination in the working areas is ensured ?	
3.4.6	Whether interlocks of Mixers are in healthy state ?	
3.4.7	Whether sand bin is provided with electro-mechanical vibrator for easy material flow ?	
3.4.8	Whether warning signals to prevent persons approaching operating mixers in place ?	
3.4.9	Whether proper storage of admixtures to prevent freezing and availability of material safety data sheets for admixtures and other chemicals are ensured ?	
3.4.10	Whether collection trays have been provided under overhead conveyor belt to prevent fall of material ?	

APPENDIX-C (CONTD.)

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

Serial No.	Points to be Checked	Remarks
3.4.11	Whether the mixing cylinder/drum has emergency manual discharge facility ?	
4.0	**Electrical Safety**	
4.1	Whether proper isolating switches/isolators are provided for all equipment in the field as well as in control room ?	
4.2	Whether proper grounding/earthing arrangement for all electrical installations metallic structures and panel boards provided and recording of earth pit resistance values planned ?	
4.3	Whether fuses of adequate rating are available to limit overloading of circuits ?	
4.4	Whether earth leakage circuit breakers in all circuits are provided and tested periodically to ensure their healthiness ?	
5.0	**Particulate Emissions**	
5.1	Whether provisions of measurement of particulate emissions are available ?	
5.2	Whether actions to be taken in case of more visual emissions are available ?	
5.3	Whether methods to prevent/control spread of dust in working areas available ?	
6.0	**General Requirements**	
6.1	Whether emergency services like fire station, first aid, hospital etc accessible ?	
6.2	Whether specific line staff/supervisors for carrying out routine, special and emergency works with certain instructions and communications identified and trained ?	
6.3	Whether do's and don'ts while handling refrigerants like ammonia and admixtures used in concrete mixing displayed promptly ?	
6.4	Whether the use of personal protective equipment like helmet, safety belt, self contained breathing apparatus/canister, hand gloves, apron, face shield, safety shoes, gumboots etc. has been ensured ?	

APPENDIX-C (CONTD.)

CHECKLIST FOR OPERATION OF READY MIX CONCRETE (RMC) PLANT

Serial No.	Points to be Checked	Remarks
6.5	Whether emergency procedures to be followed during ammonia leaks, fires, etc. are available ?	
6.6	Whether fire extinguishers are available at various critical locations ?	

PART-B

CONTROL OF WORKS
(CONTRACTORS)

7. INTRODUCTION

7.1 General

The Department of Atomic Energy(DAE) through its constituent units execute various site works either by their own manpower or by manpower of various outside agencies. The nature of contracts with outside agencies can be works contracts, engineering procurement contracts, purchase contracts, minor fabrication contracts etc. These site works involve entire gamut of conventional industrial activities like excavation, rock blasting, earth handling, construction, material handling, fabrication, installation, operation, maintenance etc. of nuclear or conventional plants/facilities. This is a challenging responsibility for the contractor due to the complexity of problems like quality of workforce (which may be unskilled, illiterate, migratory) available for labor-intensive jobs, lack of coordination among agencies at site, lack of safety awareness among concerned authorities, time schedules of project etc. As a principal employer, facility management shall be responsible to ensure health and safety of all personnel engaged for the work. In this process, the contractor through his established measures shall ensure that the guidelines are implemented. However the facility management shall monitor the compliance with the provisions outlined in the guidelines through periodic supervision and review. Any accidental injury or loss of life is detrimental to the facility as well as the society. This 'guidelines' covers the safety organisation and the safety management system requirements in sections two and three. The work specific safety precautions are covered in section four. The requirements relating to personal protective equipment and medical management are covered in sections 5 and 6.

7.2 Objective

This 'guidelines' has a basic framework of industrial safety organisation, safety management systems, safe work procedures to maintain a safe working environment for all personnel and to prevent any unsafe condition/act endangering the life of personnel engaged for industrial activities. The major objectives of this 'guidelines' are:

(i) To create awareness among workers about industrial hazards and safe working procedures.

(ii) To lay down safe work procedures and systems to be followed for different type of industrial activities.

(iii) To establish a robust safety management system.

(iv) To protect the health and ensure the safety of the workers from industrial activities.

7.3 Scope

This ‘guidelines’ is essential for implementation and assurance of conventional safety in areas such as industrial, chemical, electrical, fire, environmental and is applicable for all works executed through contracts, like engineering procurement contract, minor fabrication contract etc. Where the execution of work is envisaged in radiation controlled area or involves handling and fabrication of any nuclear material, additional precautions noted in relevant AERB safety documents on radiation protection shall also be applicable.

8. SAFETY ORGANISATION

8.1 General

(a) Construction projects have significant health and safety hazards, which need to be managed systematically since the project inception stage to achieve incident- free completion of jobs. Contractor should have well-defined safety organisation which helps in effective implementation of safety management systems and ensures health and safety of workers.

(b) The top management of contractor should assure that all the provisions of relevant Acts & Rules are conformed to.

(c) Safety organisation should carry out safety surveillance, safety training, safety enforcement measures, safety audit etc. related to all works to fulfill the overall safety requirements of this 'guidelines'.

(d) Safety functionaries should be exclusively assigned with the work related to protection of health and safety of workers.

(e) IS: 18001: 2007 gives detailed requirements of health and safety management system requirements. IS: 15793 gives requirements of good practices for managing environment, occupational health and safety legal compliance. This 'guidelines' prescribes requirements in addition to IS: 18001:2007 and IS: 15793 and gives guidelines on implementing these specific to a construction project.

(f) The requirements prescribed in various central and state regulations including *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996 and rules framed thereunder with respect to managing health and safety in construction projects, shall be complied with.

8.2 Organisational Structure for Safety Management

(a) The Contractor shall deploy qualified and experienced line management personnel for supervising the jobs to be carried out safely by workers. In order to oversee the industrial and fire safety aspects during execution of hazardous jobs (listed out in para 9.11) by the contractors, at least one safety supervisor with the qualifications and experience mentioned in Table -2 shall be in place irrespective of the man power deployed by the contractor.

(b) The qualification, experience and the minimum number of safety professionals to be deployed by contractor shall be as per the following table:

TABLE-2 : QUALIFICATION, EXPERIENCE AND NUMBER OF SAFETY PROFESSIONALS FOR CONSTRUCTION PROJECTS

Category of safety person	Mandatory requirement	Qualification
Safety officer	One in each shift (minimum) up to 1000 workers. If number of workers in a shift (including contractor's workers) exceeds 1000, additionally one safety officer should be deployed for every 1000 workers or part thereof.	Degree in engineering/ technology and diploma in industrial safety with minimum two years of experience or Diploma in engineering with diploma in industrial safety with minimum 6 years experience or A recognised degree in physics or chemistry and has practical experience of working in a factory in a supervisory capacity for a period of not less than 5 years. Not withstanding the provision contained in the above criteria any person who (i) possesses a recognised degree or diploma in engineering or technology and has had experience of not less than five years in a department of the central or state government which deals with the administration of the Factories Act, 1948 or the Dock Workers (safety, health and welfare) Act, 1986 (54 of 1986) or (ii) Possesses a recognised degree or diploma in engineering or technology and has had experience of not less than 5 years, fulltime on training, education, consultancy, or research in the field of accident prevention in industry or in any institution, shall also be eligible for appointment as a safety officer:

TABLE-2 : QUALIFICATION, EXPERIENCE AND NUMBER OF SAFETY PROFESSIONALS FOR CONSTRUCTION PROJECTS (CONTD.)

Category of safety person	Mandatory requirement	Qualification
		Provided that competent authority may, subject to such condition as it may specify, grant exemption from the requirement of this sub rule if in its opinion, a suitable person possessing the necessary qualification and experience is not available for appointment.
Safety supervisor	One in each shift (minimum) up to 500 workers or One Supervisor for any hazardous job (listed in para 9.11) if, carried out by Contractor irrespective of number of workers. If number of persons working in a shift (including the contractors' workers) exceeds 500, additionally one safety supervisor should be deployed for every 500 workers or part thereof.	Diploma in engineering and diploma in industrial safety

9. SAFETY MANAGEMENT

9.1 General

The construction agencies (contractors) shall be asked to submit a project specific health and safety plan (construction safety management plan) proposing the methodology for managing health and safety and their capability in completing the project in a safe manner.

9.2 Safety Policy

(a) The facility and the construction agency jointly or separately shall have a written statement prescribing the health and safety policy of the organisation. The health and safety policy conveys the management commitment and intent of the organisation towards health and safety, its organisation and arrangements to ensure that the set objectives are met. It also provides a framework for establishing, maintaining and periodically reviewing health and safety objectives and targets.

(b) Health and safety policy shall meet the requirements of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996 and IS 18001.

(c) The policy shall be communicated to all stakeholders through display and other means. The policy shall be displayed in local language(s) which may be understood by majority of the workmen.

9.3 Safety Plan

(a) A project specific health and safety plan shall be developed by the contractor and approved by the facility. On approval by the facility, health and safety plan shall be reference document for implementation, control and monitoring of health and safety aspects of the project by the Contractor.

(b) Project health and safety plan shall describe how the project specific health and safety objectives and targets shall be achieved. It shall define the road map for achieving the standards that an organisation lays down for itself so that efforts can be coordinated, synergized and monitored.

(c) Health and safety plan shall explain the means of establishing a positive health and safety culture at the project site. Health and safety plan shall identify and enumerate the control measures to mitigate the risks to the project completion arising out of health and safety issues so that the project is allowed to proceed without interruption and executed as per schedule.

Salient aspects that may be covered in the project health and safety plan are:

(i) Project specific health and safety objectives, targets and programmes in line with health and safety policy.

(ii) Hazard identification and risk assessment

(iii) Meeting legal and other requirements

(iv) Health and safety organisation

(v) Resources, roles, responsibility and authority

(vi) General health and safety rules

(vii) Health and safety requirements to be followed by sub-contractors

(viii) Operation control procedure

(ix) Activities requiring work permit system and its procedure

(x) Management of traffic safety inside the project

(xi) Access control of employees

(xii) Safety of visitors

(xiii) Management of critical activities such as work at height, material handling, working with plant and machinery, etc.

(xiv) Safe handling of chemicals, explosives, gas cylinders, electrical equipment etc.

(xv) Ensuring the competency and awareness of the workmen

(xvi) Fire prevention and fire fighting plan

(xvii) Emergency preparedness and response plan

(xviii) Traffic management plan

(xix) Training matrix

(xx) Personal protective equipment matrix

(xxi) Health and safety performance monitoring measures such as inspection and audit

(xxii) Incident reporting and investigation procedure

(xxiii) Proactive and reactive indicators of health and safety

(xxiv) Reward and reprimand for health and safety performance

(xxv) Checklist and formats.

(xxvi) Health monitoring plan for employees/workers exposed to hazardous jobs.

(d) The risk control measures identified shall meet the provisions of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996, other legislations and provisions of various safety related standards.

(e) Procedures shall be established for timely recording and reporting of information required for continual improvement of health and safety performance.

Internal reporting procedures shall cover:

(i) Incident reporting

(ii) Non-conformance reporting

(iii) Health and safety performance reporting

(iv) Hazard identification reporting

External reporting shall cover

(i) Statutory reporting requirements

The recording of reporting of health and safety performance shall be clearly documented in the health and safety plan.

9.4 Roles, Responsibility and Authority

(a) Contractor shall define, document and communicate the roles, responsibilities and authorities of all personnel who manage, perform and verify activities having an effect on health and safety risks. It shall also include subcontractors and visitors.

(b) The line management personnel who are responsible for execution of activities are directly responsible for health and safety in the work under their control.

(c) Health and safety group and health and safety officers are responsible for guiding the top management of their own organisation on health and safety issues and facilitating the implementation of health and safety in the project site. For duties and responsibilities of health and safety officers refer Atomic Energy (Factories) Rules-1996.

(d) Health and safety supervisors shall be engaged to assist the health and safety officers in performing their duties.

(e) Management shall provide adequate resources essential to effectively manage the health and safety management system requirements of the project.

9.5 Design and Engineering

(a) Design drawings, construction methodology and plans shall be reviewed to determine whether any additional risks may arise during the construction due to the features in the design or methodology.

Attention shall be paid to:

(i) Providing permanent hooks and loops for tying safety slings of workers

(ii) Providing holes or such arrangements to the structure to which safe working platforms and safety nets can be connected

(iii) Laying permanent slings, grab rails/bars to be used by the workers

(iv) Permanent provision for attaching railings

(v) Provision for alternative access to the trapped or distressed workers

(vi) Provision for communication

(vii) Design facilitating barricading of the area around work site without causing hindrance to building functional activities

(viii) Durability of such safety related permanent design integrated elements

(ix) Other safety practices required for the type of woks involved

(x) Significant risks from construction materials, which cannot be avoided in the design.

(b) Analysis of design and integration of safety measures, as described above, should be undertaken as value engineering through multi-stakeholder consultation, necessarily involving designers, owner/client, operation/maintenance management and construction agency.

(c) While need for special work methodology and enabling infrastructure is considered to make conditions safe for construction, attention shall also be drawn to the safety during maintenance operations (including inspections which may be necessary before project commissioning as well as maintenance).

(d) It shall also be ascertained whether it would be feasible (within the time and cost considerations) to erect necessary temporary enabling infrastructure. If, in the due assessment by the project manager, it is established that the design, as proposed, would continue to be unsafe during construction and maintenance operations unless special enabling infrastructure is created and work procedures specifically drawn, the design shall be reviewed.

9.6 Construction Planning

(a) Prior to the start of construction work, detailed planning shall be carried out which may include:

(i) Identifying aspects of design that have bearing on health and safety during construction stage.

(ii) While scheduling the various activities of the construction, allowing adequate time to carry work in accordance with health and safety requirements.

(iii) Reviewing the proposed work method of various activities, identifying health and safety hazards of activities in the project and assessment of the risk level.

(iv) When the risk level is unacceptable, taking additional control measures including revision of the work methodology so that identified risk is at ALARP (As Low as Reasonably Practicable) level.

(v) Planning and establishing the facilities for implementation of health and safety such as workmen training facility, health centre for medical check-up and first aid, access control of employees, etc.

(vi) Ensuring that the temporary establishments at project site such as site offices, workmen camps, toilets, canteens and rest sheds, etc. are created meeting the requirements of the relevant statutes and standards.

(b) Facility shall ensure that the construction agency has understood the challenges and has planned to meet the project specific health and safety requirement through appropriate competencies.

(c) Health and safety measures need proper coordination by the construction agency and such efforts of the construction agency shall be reviewed, monitored and appropriately guided by the facility.

(d) In respect of sub-contractors, project manager of the construction agency shall ensure that the sub-contractors meet the health and safety requirements of the project. Health and safety control and monitoring shall be established specific to the needs of the project.

9.7 Safety Communication

(a) Procedures shall be established to communicate significant hazards and risks to and from employees and other interested parties. The health and safety hazards and risks may be communicated in the following ways:

(i) Sharing of accidents case studies which occurred in the project site as well in other similar projects

(ii) Safety induction and orientation training

(iii) Health and safety posters and displays

(iv) Health and safety campaigns and competition involving the employees

(v) Sharing of results of the audits, inspections and other monitoring systems

(vi) Establishing a system for collecting feedback on health and safety from employees and other interested parties

(vii) Tool box meeting

(vii) Safety signage.

(b) Health and safety communications addressed to workmen shall preferably be in local language(s) understandable by majority of the workmen.

(c) The facility and construction agency shall jointly endeavour to promote a positive health and safety culture at the project. Top management of the organisations should exhibit a visible management commitment and felt leadership towards health and safety. This shall be achieved by participating in health and safety programmes such as:

(i) Project health and safety committee meeting

(ii) Health and safety walk down

(iii) Including health and safety in all performance review meetings

(iv) Exhibiting a safe behaviour while at site.

(d) The top management should clearly communicate that it considers safety as core value and it shall not allow it to get compromised. Such messages when it reaches down the level in the organisation enable to create a positive health and safety culture.

9.8 Safety Monitoring Programme

(a) The objective of the safety surveillance programme should address assurance of effective implementation of safety measures in execution of works. Following surveillance programme should be in place at sites. The safety organisation should monitor, maintain record and follow up for corrective actions.

(b) The surveillance programme should consist of identification of safety related deficiencies and status of corrections thereof, the implementation of protective measures, the safe work practices, human behavior etc.

(c) Specific surveillance should be ensured with respect to testing of equipment, portable power tools, electrical equipment and tools, hand tools, surveillance of material handling equipment, transport equipment, earth moving equipment, gas cylinders, stores, etc. to comply with various statutory requirements.

(d) Surveillance on safety awareness and training compliance including induction training, on the job training and refresher training, job specific pre-job briefing, job hazard analysis, etc. as per facility's guidelines should be ensured.

(e) Safety related deficiencies (SRDs) shall be detected by any employees/worker of construction agency and communicated to the line manager for corrective actions. The corrective action shall be monitored and records shall be maintained.

(f) Systematic updating of SRDs attended and pending should be made available by the contractor for verification of facility.

(g) The health and safety performance monitoring and measurement procedures shall provide for:

  (i) Both qualitative and quantitative measures appropriate to the project

  (ii) Monitoring the extent to which project health and safety objectives are met

  (iii) Proactive measures of compliance that measures compliance with health and safety plan, operational control procedures and legislation

  (iv) Reactive measures of performance to monitor accidents, ill health, near misses and non-conformances

  (v) Monitoring dangerous occurrences

  (vi) Fire occurrences

  (vii) First aid injuries.

(h) Health and safety inspections shall be preferably conducted by a team of the concerned engineer, health and safety officer and area in-charge of the contractor.

(i) The type of inspections that shall be carried out and the frequency shall be decided during the planning stage and documented in the project health and safety plan. The health and safety inspections should include:

(i) General site health and safety inspection

(ii) Electrical safety inspection

(iii) Plant and machinery inspection

(iv) Health and hygiene inspection

(v) Scaffolding safety inspection.

(vi) Portable tools and tackles

(vii) Lifting tools and tackles

(viii) Fire equipment inspections

(ix) Illumination level and noise level monitoring

(j) Status of health and safety implementation shall be measured and monitored by several proactive indicators which include the following:

(i) Compliance level of project health and safety plan

(ii) Compliance level of health and safety observations with in the target date

(iii) Implementation status of training plan

(iv) Implementation status of corrective and preventive actions

(v) Compliance level of pre-employment medical checks and periodic medical checkups

(vi) Compliance level of legal and other requirements

(vii) Percentage of activities for which detailed project specific risk assessment is conducted.

(k) Procedures shall be established to report, investigate and analyze incidents. The procedures shall involve:

(i) Members of the incident investigation team

(ii) Agencies to be reported in case of incidents

(iii) Time period within which incidents need to be reported

(iv) Methodology for investigation and determining the root cause of accidents.

These procedures shall form a part of the project health and safety plan and monitored on a regular basis for its effectiveness.

(l) All incidents including near miss cases, accidents and dangerous occurrences shall be thoroughly investigated, direct and root causes determined and corrective action planned. Incidents may be analysed covering the following ways to prepare and implement an effective prevention plan:

(i) Body part injured

(ii) Age of the victims

(iii) Time of accidents

(iv) Causes of accidents

(v) Nature of injury.

For detailed guidelines on analysis of incidents and computation of injury rate refer IS 3786.

(m) The following reactive health and safety indicators should be used to measure and monitor the health and safety performance of the project site:

(i) Number of near miss cases

(ii) Number of first aid cases

(iii) Lost time injury frequency rate

(iv) Lost time injury severity rate.

(n) The health and safety performance of subcontractors shall be monitored on a regular basis and necessary directive and support shall be given to achieve the set health and safety objectives and targets.

(o) All accidents leading to property damage/personnel injuries/fatal accident/near miss and dangerous occurrence should be reported to the facility's engineer-in-charge immediately

(p) All 'near-miss' accidents should also be recorded/reported and investigated and recommendations arising out should be implemented on priority.

9.9 Training/Orientation

(a) It shall be ensured that all employees are competent to perform the assigned work safely on the basis of appropriate education, training or experience. The competency requirements of different categories of employees shall be mapped and procedures shall be implemented to ensure that those deployed meet the competence requirements.

(b) The objective of health and safety training shall be to equip the employee with necessary knowledge and skill to perform the work assigned to him in a safe manner, to foster continual improvement and to imbibe safety culture.

(c) Preferably, the training should be carried out away from the working place of the participants to ensure focused attention on the training for both trainer as well as trainees.

(d) After completion of training due procedure shall be followed for obtaining the feedback from the participants on the effectiveness of the training. Effectiveness of training imparted shall be monitored for continual improvement and necessary corrections in implementation.

(e) The training/orientation programme should be implemented to meet the mandatory requirements. [Rule 43(2) (m) of the Atomic Energy (Factories) Rules 1996]. The training should be phased as follows:

(f) Induction cum orientation training should include the overall safety aspects of the work and give a general overview of the various hazards, the particular activities and the do's and don'ts. As a part of training, workers should also be given demonstrations on use of personal protective equipment, first aid and fire-fighting equipment, fire mock drills, other emergency preparedness etc.

(g) The line manager along with the safety representative should conduct pre-job briefing on day-to-day basis prior to specific hazardous jobs. This will make the workers aware of the hazards and the precautions to be taken.

(h) Refresher training should be imparted to each worker at least once in a year.

(i) A training schedule should be prepared by the construction agency and communicated to facility for concurrence.

(j) Records of training, demonstration and pep talk should be maintained.

9.10 Permit to Work System

(a) Activities requiring permit to work shall be decided before starting the construction and shall be suitably documented in the project health and safety plan. Some of the activities which shall require permit to work are:

(i) Excavation

(ii) Entry into confined spaces

(iii) Electrical work (HV/LV)

(iv) Opening manholes, covers and grills

(v) Blasting operation

(vi) Hot work

(vii) Work on plant and machinery and other power driven equipment

(viii) Working at height

(ix) Working at night

(b) The contractor should establish a permit to work system for any other hazardous activity, which it feels necessary to be controlled administratively for safe execution.

(c) Contractor should obtain valid safety work permit before carrying out any hazardous job and shall maintain a copy of it with him through out the period of his work. Record of safety work permit should be maintained in a systematic manner. All the safety conditions and requirements stipulated in the safety work permit should be ensured strictly.

(d) Contractor should ensure that only authorized personnel are deployed for hazardous works/jobs (refer item 3.11 for hazardous job) and provide facilities for the same.

9.11 Job Hazard Analysis

(a) It should be ensured by contractor that a safe work procedure exists for all the hazardous jobs as mentioned hereunder and the requirements of the safety procedures are ensured at the work sites. Job hazard analysis (JHA) should form a part of such safe work procedures. A checklist based on JHA should be prepared. This checklist should be crosschecked by the line managers and verified by safety officer.

Typical list of jobs requiring job hazard analysis (This list is illustrative only and not exhaustive) is as follows:

(i) Excavation

(a) Blasting including under water blasting

(b) Earth and stone removal/backfilling/dumping of earth/ stones

(c) Any excavation more than 1.8 m depth.

(ii) Work at height (working beyond 3.5 meters above ground)

(a) Erection and dismantling of scaffolding, platforms, shuttering/de-shuttering work

(b) Dome work, rod bending, construction of chimney and cooling towers

(c) Working on tower crane.

(iii) Materials and material handling

(A) Critical equipment handling e.g.

(a) Calandria

(b) Steam generators

(c) Turbine generator components

(d) Diesel generator set

(e) Generator stator

(f) End shields

(g) Fuelling machines components

(h) Heat transport pumps etc.

(B) Hazardous chemical handling e.g.

(a) Acids and alkalis

(b) Ammonia

(c) Chlorine

(d) Freon

(e) Hydrazine

(f) Hydrogen sulphide

(g) LPG

(h) Morpholine

(C) Movement of heavy material by crane

(D) Movement of tractor trolley on slopes

(E) Manual lifting of heavy material to height

(F) Erection of heavy machinery, equipment.

(iv) Electrical connection

(a) Field connection for electrical installation

(b) Installation of lighting fixtures

(c) Charging of electrical system

(d) Charging of transformer, switch yard, switch gears

(e) Working near high voltage lines

(f) Use of portable electrical tools.

(v) Equipment/structural erection work

(a) Material handling

(b) Loading and unloading

(c) Transportation of material from one place to other

(d) Steel fabrication and erection

(e) Cleaning and maintenance of batching plant equipment.

(vi) Finishing/painting work

(a) Painting at height

(b) Painting in confined space.

(viii) Other specific work

(a) Work with pneumatic tools/compressed air

(b) Work on pressure vessels/lines

(c) Work in the vicinity of steam lines

(d) Work in high enthalpy area

(e) Work in high noise area

(f) Work in confined space including tunnels and trenches

(g) Work in isolated area (away from main site)

(h) Radiography work

(i) Work related to welding, gas cutting, grinding

(j) Working near conveyor, rotating machine

(k) Leak detection testing.

9.12 Reward

(a) To motivate the employees and organisation to work safely measures can be implemented based on the suitability. Selection and rewarding for the following categories may be considered on regular basis:

(i) Safest workmen

(ii) Safest supervisor

(iii) Safest area

(iv) Safest sub-contractor, etc.

(v) Sub-contractors and employees may be rewarded when the project achieves significant million man-hours without any lost time injury.

10. WORK SPECIFIC SAFETY MEASURES

10.1 General

(a) The contractor should ensure that safety precautions are taken during the execution of awarded work and work areas are maintained safe at all times. At the end of each shift and at all times when the work is suspended, it should be ensured that the work area is left safe in such a way that no materials and equipment that can cause damage to existing property, personal injury or interfere with the other works of the project or station are left in an unsafe manner.

(b) The contractor should ensure to provide and maintain all lights, guards, fencing, warning signs, caution boards and other safety measures and provide for vigilance as and when necessary for the protection of workers and for the safety of others. The caution boards should also have appropriate symbols.

(c) Adequate lighting facilities such as floodlights, hand lights and area lighting should be provided at the site of work, storage area of materials and equipment and temporary access roads within the working area.

(d) All works should be planned so as to avoid interference with other facilities, works of other contractors or sub-contractors at the site. In case of any interference, necessary coordination should be ensured for safe and smooth working.

(e) It should be ensured that the instructions given by the safety officer or his designated nominee regarding safety precautions, protective measures, housekeeping requirements, etc. are complied with. The safety officer with due intimation to line manager should have the right to stop the work, if in his opinion, proceeding with the work will lead to an unsafe and dangerous condition. Line manager should arrange to get the unsafe condition rectified and/or provide appropriate protective equipment.

(f) Contractor should ensure that each job with a hazard whether small or big is intimated to the Head, industrial safety of the facility well before it is taken up.

(g) The contractor should be fully responsible for non-compliance of any of the safety measures or requirements, implications, injuries, fatalities, dangerous occurrences and compensation arising out of such situations or incidents.

(h) Maximum duty hours of an individual should be as per the Factories Act 1948 or its latest amendment.

(i) Illumination levels should be as per the statutory requirements.

10.2 Rock Blasting

(a) All blasting operations should be carried out on the basis of procedures approved by Head, industrial safety and engineer-in-charge. All works in this connection should be carried out as per BIS specification/code (IS 4081: 1986. Title:- Safety code for blasting and related drilling operations (First Revision)). Barricades, warning signs etc. should be placed on the roads/open area.

(b) Blasting permit should be obtained from Head, Industrial Safety at least one day before the blasting operation and precautions mentioned there in shall be ensured by the engineer-in-charge before blasting operation.

(c) The blaster should have a licence from competent authority under Explosive Rules, 1983 for blasting work. It should also be ensured that he knows about the risks involved.

(d) Blasting should be done under the supervision of competent engineer/ supervisor.

(e) Blasting in the open site should only be carried out during fixed hours every day/fixed day in the week between sunrise and sunset. Residents of adjacent area should be informed in advance about the blasting schedule.

(f) No blasting should be undertaken during thunderstorm.

(g) Necessary precaution should be taken to ensure the stability/integrity/ safety of the adjacent structure by limiting the peak particle velocity.

(h) No loose material, such as tools, drilling equipment, etc. should be left on the surface to be blasted. Proper muffling arrangement of the blasting area should be ensured to avoid flying of blasted material.

(i) Authorized blaster should personally ensure that all the personnel/ equipment has been removed from the blasting area before the blasting operations.

(j) Blasting area should be free of detonating gas, inflammable objects, sparking or damaged wiring system, stray currents and static electricity.

(k) All electrical lines in blasting area should be de-energised.

(l) Entry of unauthorized personnel should be prevented by displaying warning signs.

(m) In case of misfire, no person should be allowed to approach the blasting site unless it is inspected and cleared by a competent engineer/supervisor.

(n) Explosives and blasting material should be stored only in clean, dry, well-ventilated, suitably constructed bullet/magazine which should be fire resistant and securely locked. Stock book should be kept accurate and maintained. Licence should be obtained for storage of explosive as per the Explosives Act, 1884.

(o) Blasting caps, electric blasting caps or primers and detonators should not be stored in the same box, container or room with other explosives.

(p) Precautions against lightening should be provided in accordance with Indian Electricity Rules, 1956 (amended in 2000).

(q) The explosives should be transported in specially designed vehicles bearing a special sign or inscription entitled 'DANGER-EXPLOSIVES'. Also detonators separated from other explosive should be transported in a separate compartment.

10.3 Excavation, Trenching and Earth Removal

(a) Before taking up excavation work, necessary permission should be obtained from the engineer-in-charge with reference to existing underground services.

(b) The Line manager of the works should exercise full care to ensure that no damage is caused by him or his workmen, during the operation/excavation etc., to the existing water supply, sewerages, power or telecommunication lines or any other services or works. He should provide and erect before construction, substantial barricades, guardrails, and warning signs around the work area. He should also furnish, place and maintain adequate warning lights, display board, signals etc., as required.

(c) All trenches 1.2 m or more in depth should at all times be supplied with at least one ladder for every 30 m along the trench. Ladders shall extend from bottom of the trench to at least 1 m above the surface of the ground.

(d) The sides of the trench/pit in soil, which are 1.2 m or more in depth should be stepped back to give suitable slope (angle of repose) or securely held by timber bracing or appropriate shoring/support, to avoid the danger of soil slides from collapsing. The excavated material should not be placed within 1.5 m or half of the depth of the pit whichever is more from edges of the trench/pit. Cutting should

be done from top to bottom. Under no circumstances mining or under-cutting should be done.

(e) Workers should not be exposed to the danger of being buried by excavated material or collapse of shoring. Measures to prevent dislodgment of loose or unstable earth, rock or other material from falling into the excavation by proper shoring shall be ensured.

(f) The stability and safety of the excavation, adjacent structures, services and other works should be ensured.

(g) All excavated area should be fenced off by suitable railing and installation of caution board to warn the persons from slipping or/ falling into the excavation pit/ mound.

(h) All excavated areas shall have an illumination level of at least 20 lux for night work and a red danger light shall be displayed at prominent place near the excavation site to warn approaching traffic and men.

(i) For removal of earth from an earth mound/excavated heap a written permission should be obtained from the engineer-in-charge of the work. As far as practical, earth should be removed mechanically. Wherever manual removal of earth is involved, earth should be removed from the top by maintaining a slope equal to the angle of re-pose of the earth. Such work should be constantly supervised to ensure that no under-cutting is done and to ensure that no person is trapped.

(j) Dumping of excavated soil should be done at a specified area under proper supervision with respect to signaling, illumination and safety clearance.

(k) It should be ensured that at a construction site of a building or other construction work, every vehicle or earth moving equipment is equipped with (a) silencers, (b) tail lights, (c) power and hand brakes, (d) reversing alarm (e) search light for forward and backward movement, which are required for the safe operation of such vehicle or earth moving equipment and (f) the cab of the vehicle or earth moving equipment is kept at least one meter from the adjacent face of a ground being excavated. (g) indicator etc.

(l) It should be ensured that when a crane or shovel is traveling, the boom of such crane or shovel is in the direction of such travel and the bucket or scoop attached to such crane or shovel is raised and without load, except when it is traveling downhill.

(m) Before loading or unloading power trucks or trailers attached to tractors, the brakes should be applied and if vehicle is on a sloping

ground, the wheels should be blocked. Handcart should not be used for the transfer of construction/erection materials in the construction area. However if the exigency demands urgent transfer of light materials a small handcart may be permitted with the prior approval of the Engineer-in-charge.

(n) It should be ensured that at a construction site of a building or other construction work:

(i) All transport or earth moving equipment and vehicles are inspected at least once in a week by responsible persons and in case any defect is noticed in such equipment or vehicle, it is immediately taken out of service.

(ii) Safe gangways are provided for to and fro movement of building workers engaged in loading and unloading of lorries, trucks, trailers and wagons.

(iii) All earth moving equipment, vehicles or other transport equipment be operated only by such persons who are adequately trained and possess such skills as required for safe operation of vehicles or other transport equipment.

(iv) Trucks and other equipment are not loaded beyond their safe carrying capacity, which should be clearly marked on such trucks and other equipment.

(v) No unauthorised person rides the transport equipment employed in such work.

(o) It should be ensured at a construction site of a building or other construction work that:

(i) A shovel or an excavator whether operated by steam or electric or by internal combustion used for such work is constructed, installed, operated, tested and examined as required under any law for the time being in force and the relevant national standards.

(ii) Buckets or grabs of power shovels are propped to restrict the movement of such bucket or grabs while being repaired or while the teeth of such bucket or grabs are being changed.

(p) It should be ensured at a construction site of a building or other construction work that:

(i) An operator of a bulldozer before leaving - applies the brakes, lowers the blade and ripper and puts the shift lever into neutral.

(ii) A bulldozer is parked on level ground at the close of the work.

(iii) The blade of a bulldozer is kept low when such bulldozer is moving uphill.

(iv) Bulldozer blades are not used as brakes except in an emergency.

(q) It should be ensured at a construction site of a building or other construction work that:

(i) A tractor and a scraper are joined safely at the time of its operation

(ii) The scraper bowls are propped while blades of such scraper are being replaced.

(iii) A scraper moving downhill is driven in low gear.

(r) It should be ensured at a construction site of a building or other construction work that:

(i) Before a road roller is used on the ground, such ground is examined for its bearing capacity and general safety, especially at the edges of slopes such as embankments on such grounds.

(ii) A roller is not moved down hill with the engine out of gear.

(s) Vehicle carrying excavated material should have proper cover over the driver's cabin.

10.4 Safe Means of Access/Platforms

(a) Adequate safe means of access and exit should be provided for all work places, at all elevations.

(b) Suitable scaffolds should be provided for workmen for all works that cannot be done safely from the ground, or from solid platform except such short duration work that can be done safely from ladders. Bamboo/wooden scaffolding should not be permitted.

(c) Where the platform for working is more than 3.5 m above ground, the width of the platform should be minimum 1 m.

(d) Ladder should be of rigid construction having sufficient strength for the intended loads. Wooden/bamboo/rope ladders should not be permitted. All ladders should be maintained in good condition. The ladders should be fixed to the ground or rigid platforms. An additional person should be engaged for holding the ladder, if ladder is not securely fixed. Ladder shall be extended from floor to at least one meter above the platform.

(e) A portable ladder should be given an inclination not steeper than 1 in 4 (1 horizontal and 4 vertical). Ladders should not be used for climbing while carrying materials in hands. While climbing both the hands should be free.

(f) Any working platform on scaffolding or staging more than 3.5 m above the ground or floor should have a guard rail attached, bolted, braced at least 1.0 m high above the floor or platform of such scaffolding or staging along with mid-rail.

(g) The planks used for any working platform should not project beyond the end supports to a distance exceeding four times the thickness of the planks used. The planks should be rigidly fixed at both ends to prevent sliding, slipping or tilting. The thickness of the planks should be adequate to take load of men and materials and should not collapse. Plywood or packing wood should not be used as planks.

(h) The guardrail should extend along the entire exposed length of the scaffolding with only such opening as may be necessary for the delivery of materials. Standard railing should have posts not more than 2 m apart and an intermediate rail halfway between the floor or platform of the scaffolding and the top rail. Such scaffolding or staging should be so fastened as to prevent it from swaying from the building or structure. Scaffolding and ladder should conform to IS 3696 (Part I): 1987 and (Part II): 1996.

(i) Working platforms of scaffolds should have toe boards at least 15 cm in height to prevent materials from falling down.

(j) A sketch of the scaffolding proposed to be used should be prepared and approval by the engineer-in-charge obtained prior to start of erection of scaffolding. All scaffolds should be examined by engineer-in-charge before use.

(k) Working platform, gangways and stairways should be so constructed that they should not sag unduly or unequally and if the height of the platform or gangway or stairway is more than 3.5 m above ground level or floor level, they should have adequate width for easy movement of persons and materials and should be suitably guarded.

(l) No single portable ladder should be used for access to a height of more than 4.5 m. For ladders up to 3m in length the width between styles (side bars)/width in the ladder should in no case be less than 300 mm. For longer ladders this width should be increased by at least 20 mm for each additional meter of length. Step/rungs spacing should be uniform and should not exceed 300 mm. Portable ladder should be used only for access to work place. In case work place is higher than 4.5 meters, pre-fabricated steel staircase should be used.

10.5 Work at Height

(a) Person to work at height should be medically fit and should have height pass issued by safety section. (Appendix-D Part A, B and C). Safety training should be imparted before working at height.

(b) Safety work-permit system for working at height should be obtained from industrial safety section.

(c) At elevated places, secure access and foothold should be provided. Adequate and safe means of access and exit should be provided at all work places for all elevations. Means of access may be portable or fixed ladder, ramp or a stairway. The use of crosses, braces or framework, as a means of access to the working platform should not be permitted.

(d) Linear movement at height should be reduced to minimum. In case of such movement provision for anchoring the safety belt should be made.

(e) Where barricades cannot be installed, a safety net of adequate strength should be installed close to the level at which there is a danger of fall of personnel/fall of objects.

(f) In case where 'work at height' is on asbestos roof, crawling board/ roof ladder should be used to walk across the asbestos roof.

10.6 Electrical Safety

(a) All electrical installations shall comply with the appropriate statutory requirements given below and shall be subject to approval of the Electrical Engineer and Safety Officer.

(i) The Electricity Act, 2003

(ii) The Indian Electricity Rules 1956 (as amended in 2000)

(iii) The National Electricity Code 2008

(iv) Atomic Energy (Factories) Rules, 1996

(v) Other relevant rules of Statutory Bodies and power supply authority

(vi) Relevant standards of BIS

In addition to the above statutory provisions, the clauses indicated in this document shall also be complied.

(b) It shall be the responsibility of the user seeking temporary power supply to indicate in writing, if any of the clauses (requirements

noted in above regulations and in this document) are conflicting with each other and for which the user cannot decide the course of action regarding safe installation, commissioning, operation, maintenance and decommissioning of the electrical installations.

(c) The electrical engineer and safety officer of the agency providing temporary power supply shall interpret the concerned conflicting clauses and approve in writing the safe course of action.

(d) The application Form-1 (Form-1A, 1B and 1C) as mentioned in Appendix-E should be submitted by the user for getting the temporary power supply.

(e) After installation of temporary electrical panels, wiring works by the user, Certificates as per Form-1D (Appendix-E) should be submitted to the provider.

(f) Certificate of safety officer and authorization of electrical engineer for energisation of temporary power supply should be filled as per Form-1E (Appendix-E).

10.7 Material Handling and Lifting Machines and Tackles

(a) It should be made compulsory to supervise jobs like lifting/placing/loading/unloading/carrying/transporting etc. of heavy material by qualified supervisor having knowledge about hazards involved and precautions to be taken for such job.

(b) The line managers should ensure that the material handling equipment used is adequate to handle the load.

(c) Manual pulling of heavy equipment and trolley loaded with heavy material is not to be permitted.

(d) Stacking and handling of heavy materials should be done on a firm ground to prevent settlement.

(e) No lifting machine and no chain, rope or lifting tackle, except a fiber rope or fiber rope sling, shall be taken into use for the first time in that factory unless it has been tested and all parts have been thoroughly examined by a competent person. A certificate of such a test and examination specifying the safe working load or loads and signed by the person making the test and the examination has been obtained and is kept available for inspection.

(f) Use of lifting machines and tackles should conform to relevant BIS requirements [IS 13367 (Part 1): 1992 Reaffirmed 2003, IS 4573: 1982 (Reaffirmed 2000) and IS 13834 (Part 1): 1994 Reaffirmed 2003 etc. The accessories and the attachments, anchorages and

supports etc. should be ensured in healthy conditions by regular inspections at defined frequencies.

(g) Every rope used in hoisting or lowering materials or as a means of suspension should be of good quality and adequate strength and free from any defect. This should be ensured by regular inspection as per IS 2762: 1982- Specification for wire rope slings and sling legs (first revision).

(h) Every crane operator or lifting appliance operator should be authorized. No person under the age of 18 years should be in charge of any hoisting machine or give signal to an operator of such machine.

(i) In case of every lifting machine (and of every chain, ring, hook, shackle, swivel and pulley block used in hoisting or as a means of suspension) the safe working load should be ascertained and clearly marked. In case of a lifting machine having a variable safe working load, each safe working load and the conditions under which it is applicable should be clearly indicated. No part of any machine should be loaded beyond the safe working load except for the purpose of testing. This should be approved by the engineer-in-charge and Head, Industrial Safety.

(j) In case of facilities machines, the safety of the machines shall be ensured by the Engineer-in-charge. As regards the Contractor's machines, the contractor should declare the safety of the machine to the Engineer-in-charge whenever he brings any machinery to site of work and get it verified by the engineer-in-charge, supported by a valid test certificate by the competent person.

(k) Thorough inspection and load testing of lifting machines and tackles should be done in the presence of competent person at least once in every 12 months and records of such inspections and testing should be maintained.

(l) No mobile crane should be allowed to move under live high-tension power transmission line.

(m) While lifting loads, cranes should be located on level ground.

(n) A thorough load analysis should be carried out before using cranes in tandem.

(o) Motors, gear transmission, couplings, belts, chain drives and other moving parts of hoisting appliances should be provided with adequate safeguards. Hoisting appliances should be provided with such means, which will reduce the risk of any part of a suspended load becoming accidentally displaced or lowered.

(p) It should be ensured that the cabin of the lifting machine in outdoor service:

(i) is made of fire resistant material,

(ii) has a suitable seat, a footrest and protection from vibration,

(iii) affords the operator an adequate view of the area of operation,

(iv) affords the operator adequate protection against the weather, and

(v) is provided with fire extinguisher.

10.8 Welding and Gas Cutting

(a) Welding and gas cutting operations should be done by qualified and authorized persons only.

(b) Safety work permit shall be obtained (wherever necessary like presence of flammable or combustible material etc.) before flame cutting/welding is taken up.

(c) Welding and gas cutting should not be carried out in places where flammable or combustible materials are kept and where there is danger of explosion due to presence of gaseous mixtures. In case the requirement cannot be avoided, specific approval and procedure should be ensured and adequate precautions should be taken.

(d) Welding and gas cutting equipment including hoses and cables should be maintained in good condition.

(e) Barriers should be erected to protect other persons from harmful rays from the work. When welding or gas cutting is done in elevated positions, precautions should be taken to prevent sparks or hot metal falling below on persons or combustible materials.

(f) Suitable type of protective clothing consisting of fire resistant gauntlet gloves, leggings, boots and aprons should be provided to workers as protection from heat and hot metal splashes. Face shields with filter glasses of appropriate shade should be worn.

(g) Adequate ventilation should be provided while welding, brazing and cutting the metals like zinc, brass, bronze, galvanised or lead coated material.

(h) Welding and gas cutting on drums, barrels, tanks or other containers should be taken up only after ascertaining that they have been emptied, cleaned thoroughly and made free of flammable material.

(i) Fire safety measures should be available as required near the location of welding/cutting operations.

(j) Flash back arrestor should be provided with gas cutting and gas welding sets.

(k) For electric (Arc) welding the following additional safety precautions should be taken:

(i) When electrical welding is undertaken the return lead of welding machine should be directly connected to the job invariably.

(ii) Provision must be in place in electric welding machine to prevent physical contact with live parts.

(iii) The welding cables and power cables should be routed separately to avoid entanglement.

(iv) The electric welding set should have suitable earth connections. There should be an electrical isolation device in the input power supply side on the welding machine.

(l) Double gauges should be used for all gas cylinders used for cutting/ welding. Pressure gauges/regulators should be in healthy condition.

10.9 Rotary Cutters/Grinders

(a) All portable cutter/grinders should be provided with the wheel guard in position.

(b) Grinding wheels of specified diameter only should be used on all grinders in order to limit the prescribed peripheral speed.

(c) In pedestal grinder, the gap between tool rest and grinding wheel should be maintained less than 3 mm.

(d) Goggle/face shield should be used during grinding operation.

(e) No grinding wheel should be used after its expiry date.

(f) Ear muff/ear plug should be used during the welding /cutting jobs.

(g) Portable appliances, which are powered by single phase AC supply, shall be provided with three-core cable and three pin plug, otherwise the whole body should be double insulated.

(h) Safety work permit should be obtained (wherever necessary like presence of flammable or combustible material etc.) before grinding is taken up.

(i) Fire safety measures should be available as required near the location of grinding operations.

10.10 Concrete Mixing Equipment

(a) Cement bags should be stacked on wooden planks in dry and leak proof area, 150 mm to 200 mm from the floor and 450 mm away from walls. Height of the stack should not be more than 15 bags or 1.5 meters which ever is lower. Width of the stack should not be more than 4 bags or 3 meters. Lateral loading of the walls of the storage room by stacking should not be permitted. Stacking of the bags should not be used as a working platform.

(b) Shuttering and supporting structures should be of adequate strength and approved by engineer-in-charge. This should be ensured before concrete is poured.

(c) If the mixer has a charging skip the operator should ensure that the workmen are out of danger before the skip is lowered.

(d) Adequate walking platforms are to be provided in the reinforcement area to ensure safe walking for pouring concrete on the roof.

(e) When workmen are working/cleaning the inside of the drum of mixer, the power of the mixer should be switched off and 'Do not operate' tag should be provided. The plant operation and cleaning of mixing pan should be carried out as per equipment supplier's instructions.

(f) Interlocks between the cover and the mixer rotor shall be established to ensure that the agitator does not start when the cover is in open condition.

(g) It should be ensured that moving parts of the elevators, hoists, screens, bunkers, chutes and grouting equipment used for concrete work and of other equipment used for storing and transporting of ingredients of concrete are securely fenced to avoid contact of workers with such moving parts.

(h) It should be ensured that screw conveyors used for cement, lime and other dusty material are completely enclosed.

(i) Workers engaged for handling bulk cement in a confined place should be provided with tight fitting goggle, approved respirators and protective clothing, which will fit snugly around the neck, wrist and ankles.

(j) The following should be ensured for every pipe carrying pumped concrete:

  (i) The scaffolding carrying a pipe for pumped concrete should be strong enough to support such pipe at a time when such pipe is filled with concrete or water or any other liquid and to bear safely all the building workers who may be on such scaffold at such time.

(ii) Securely anchored at its end point and each curve on it.

(iii) Provided with an air release valve near the top of such pipe; and securely attached to a pump nozzle by a bolted collar or other adequate means.

(k) The following should be ensured while using the electric vibrators in concreting work at a construction site of a building or other construction work such that:

(i) Such vibrators are earthed.

(ii) The leads of such vibrators are heavily insulated.

(iii) The current is switched off when such vibrators are not in use.

10.11 Painting

(a) Appropriate breathing air respirators should be provided for use by the workers when paint is applied in the form of spray, or a surface having lead paint is dry rubbed or scraped.

(b) Only the quantity of paint, thinner and polish required for the day's work should be kept at the work spot. Excess storage should not be permitted at the work spot.

(c) Smoking, open flames or sources of ignition should not be allowed in places where paints, varnish, thinner and other flammable substances are stored, mixed or used. A caution board, with the instructions written in national language and regional language, 'SMOKING - STRICTLY PROHIBITED' should be displayed in the vicinity where painting is in progress or where paints are stored. Symbols should also be used on caution boards.

(d) All electrical equipment of paint storage room should be of explosion proof design. Suitable fire extinguishers / sand buckets should be kept available at places where flammable paints are stored, handled or used.

(e) When painting work/hot resin mix is done in a closed room or in a confined space, adequate ventilation should be provided and ensured. In addition, suitable respirators should be provided. No portable electric light or any other electric appliance of voltage exceeding 24 volts should be permitted for use inside any confined space. Walkie-talkie or other means of communication should be provided. Rescue arrangement like full body harness with lifeline, tripod with pulley and extra BA sets should be available.

(f) The workers should use PVC gloves and/or suitable barrier creams to prevent the skin contact with Epoxy resins and their formulations used for painting.

10.12 Demolition

(a) Before any demolition work is commenced and also during the progress of the work, all roads and open area adjacent to the work site should either be closed or suitably cordoned. Appropriate warning signs should be displayed for cautioning approaching persons/ vehicles.

(b) Before demolition operations begin, it should be ensured that all the service lines are de-energized.

(c) Persons handling demolition operations shall use appropriate PPE.

(d) All demolition operations should be carried out with safe and duly approved procedures which shall include following but not limited to:

(i) No masonry/material should be permitted to fall in such masses or volume or weight so as to endanger the structural stability of any floor or structural support.

(ii) No wall, chimney or other structure or part of a structure is left unguarded in such a condition that it may fall, collapse or weaken due to wind pressure or vibration.

(iii) No floor roof or other part of the building should be overloaded with debris or materials as to render it unsafe.

(e) After the demolition, the debris and other materials collected should be disposed safely and not permitted to be dropped freely.

(f) Entries to the demolition area shall be restricted to authorized persons wearing safety helmets and safety shoes.

10.13 Traffic

(a) All the vehicles moving at sites should conform and comply with the requirements of Motor Vehicles Act, 1988 and the Rules made thereunder. All the drivers /operators of vehicles should possess valid driving license as per Motor Vehicles Act, 1988 or its latest amendment.

(b) When the construction work causes interference with traffic such as road cutting or transit unloading of heavy equipment etc. notice of such interference should be given to the engineer-in-charge and Head, industrial safety well in advance with the details of start of the work and time required.

(c) A cleaner/assistant must be available for all heavy vehicles whenever vehicles move forward as well as in the reverse direction. All vehicles should be fitted with proper reverse horns, back view mirrors and indicator signals.

(d) Facility shall ensure that the assessment of the driver's visual ability is carried out as per Rule 55 of the Atomic Energy (Factories) Rules, 1996/guidelines of advisory committee on occupational health (ACOH), AERB or as per the latest amendments in statutes.

(e) Effective speed breakers with yellow stripes on the roads to regulate the speed at the vulnerable points should be installed. Effective barricading with adequate caution signs should be placed to warn the vehicle drivers whenever the jobs are carried out on the road.

(f) All vehicles moving at the site should have roadworthiness certificate issued by the concerned authority.

(g) Special limit boards and caution boards indicating turns should be installed wherever necessary.

(h) In general, the following maximum speed limits should be specified and implemented. Vehicles speed limits should be as per Motor Vehicle Act or 20 Km/h. Extra precautions and care should be exercised particularly during heavy material/equipment movements.

(i) Safety awareness programmes should be conducted for all the drivers of the light, medium and heavy vehicles.

10.14 Work in Radiation Area

The facility shall follow the stipulations under Atomic Energy (Radiation Protection) Rules, 2004 and AERB Safety Manual on 'Radiation Protection for Nuclear Facilities'[AERB/NF/SM/O-2 (Rev.4)] with regard to work in the radiation area and other works related with radiography, etc.

10.15 Work in and Around Water Bodies

(a) When work is done at a place where there is risk of drowning, all necessary rescue equipment such as life buoys and life jackets should be provided and kept ready for use.

(b) All necessary steps shall be taken for prompt rescue of any person in danger and adequate provision should be made for prompt first-aid treatment of all injuries likely to be sustained during the course of the work. Proper record of entry/exit to and from water bodies shall be maintained on shift basis and search operation shall be conducted as soon as any person is detected to be missing.

(c) Caisson Work

(i) Safe means of access should be provided to the place of work in the caisson and adequate means should be provided to safely reach the top of caisson in the event of inrush of water.

(ii) The work relating to construction, positioning, modification or dismantling of caisson shall be done under the supervision of a responsible person.

10.16 Fire Safety

(a) Provisions prescribed in the AERB safety standard on 'Fire Protection Systems for Nuclear Facilities', [AERB/NF/SS/FPS (Rev. 1)] shall be complied.

(b) All necessary precautions should be taken to prevent outbreak of fires at the construction site. It should be ensured that all hot works are carried out under valid work permit.

(c) Combustible materials such as wood, cotton waste, oil, coal, paints, chemicals etc., should be segregated and kept to the required bare minimum quantity at work place.

(d) Containers of paints, thinners and allied materials should be stored in a separate room which should be well ventilated and free from excessive heat, sparks, flame or direct rays of the sun. The containers of paint should be kept covered or properly fitted with lid and should not be kept open except while using.

(e) Adequate number of trained persons from approved fire training centre required to extend fire safety coverage should be ensured.

(f) Fire extinguishers as approved by the engineer-in-charge/in-charge of fire station/safety in-charge should be located at the construction site at appropriate places.

(g) Adequate number of trained workmen in fire fighting who can operate fire extinguishers should be ensured.

(h) Portable fire extinguishers with periodic inspection, maintenance and re-filling complying with the mandatory requirements should be ensured.

(i) Availability of adequate water for fire fighting should be ensured.

(j) Implementation of the provisions of various statutory licenses for storing gas cylinders, petroleum products, explosives etc. as per the relevant Acts and Rules should be ensured wherever required.

10.17 Environmental Safety

Relevant provisions of the state/central statutory authority regarding environment protection should be adhered to.

10.18 Public Protection

The Contractor should make necessary provisions to protect the public. He should be bound to bear the expenses in defense of every action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of any precaution required to be taken to protect the public. He should pay for the any such damage and cost which may be awarded in any such suit, action or proceedings to any such person, or the amount, which may be fixed as a compromise by any such person.

10.19 Safety of Visitors

(a) Visitors for the project shall be given health and safety induction before they are allowed in to the construction project. It shall include the minimum PPE to be used, hazards and risks at the work area, restricted areas of entry, emergency response arrangements, etc.

(b) Visitors shall always be accompanied by one of the employees of the project site.

(c) Visitors shall not be allowed in the hazardous areas unless they are competent and trained to work in such areas.

10.20 Housekeeping

(a) It should be recognized that a proper place for everything and everything in its place is maintained for a good housekeeping.

(b) The material required for immediate use only should be brought to the designated workplace and stacked properly and labeled suitably.

(c) All work spots, site office and surroundings should all times be kept clean and free from debris, scrap, concrete muck, surplus materials and unwanted tools and equipment. A day-to-day collection and disposal of scraps/debris should be done safely at designated place.

(d) Electrical cables should be so routed as to allow safe traffic by all concerned. Cable should be preferably supported on the brackets fixed along the wall to maintain safe access. Wherever routing on the floor cannot be avoided, care should be taken to ensure mechanical protection of these cables and safe access is not disturbed.

(e) No material at any work place should be so stacked or placed or disposed off as to cause danger, inconvenience or damage to any person or environment.

(f) All unused scaffoldings, surplus/scrap materials and equipment/ systems like temporary electrical panels etc. should not be allowed to accumulate and shall be removed from the premises at the earliest.

(g) Accumulation of water /oil spillages on the floor or any other workplace should be avoided.

(h) Proper aisle space marking should be provided in all workplaces.

10.21 Other Statutory Provisions

Notwithstanding the clauses in the above subsections, there is nothing in these clauses to exempt the contractor from the provisions of any other Act or Rules in force in the Republic of India. In particular, all operations involving the transport, handling, storage and use of explosives should be as per the standing instructions and conform to the Indian Explosives Act, 1884 and the Explosives Rules, 1983. Handling, transport, storage and use of compressed gas cylinders and pressure vessels should conform to the Gas Cylinder Rules 2004 and Static and Mobile Pressure Vessels (Unfired) Rules 1981. In addition, The Indian Electricity Act 2003 and Indian Electricity Rules 2005, the Atomic Energy Act, 1962, the Radiation Protection Rules, 2004, the Atomic Energy (Factories) Rules, 1996 and AERB safety manual on 'Radiation Protection for Nuclear Facilities' [AERB/NF/SM/O-2 (Rev.4)] should be complied with.

11. PERSONAL PROTECTIVE EQUIPMENT

11.1 General

Although the primary approach in any safety effort is that the hazard to the workmen should be eliminated or controlled by engineering methods rather than protecting the workman through use of personal protective equipment (PPE). Engineering methods could include design change, substitution, ventilation, mechanical handling, atomization etc. Under those situations when it is not possible to introduce any effective engineering methods for controlling hazards, it is necessary that workman use appropriate type of PPE. For example, in construction work there is the possibility of a hand tool, a bolt, or some loose material to fall from an elevated level and striking the head of workman working below. It is therefore necessary that construction worker wear a safety helmet. It is for such situations, both the Factories Act 1948 and the Atomic Energy (Factories) Rules, 1996 have provisions for use of appropriate type of PPE.

It is thus recognized that use of PPE is an important and necessary consideration in the development of a safety programme. Once the safety professional decides that PPE is to be used by workmen, it is essential to select right type of PPE and construction agency should ensure that workman uses it and also PPE is correctly maintained.

11.2 Personal Protective Equipment (PPE)

(a) All personal protective equipment as considered necessary should be made available for the use of the persons employed on the site and maintained in a condition suitable for immediate use. Also adequate steps should be taken by line manager to ensure proper use of PPE.

(b) All the PPEs in use should be as per relevant IS standards as referred in the AERB safety guidelines on 'Personal Protective Equipment' (AERB/SG/IS-3).

(c) All persons employed at the construction site should use safety helmets. Safety helmet should be with BIS mark and should have its headband with back support and chin strap.

(d) Workers employed on mixing asphaltic materials, cement and lime mortars should use protective goggles, protective foot wears, hand gloves and respirators as required.

(e) Persons engaged in welding and gas-cutting works should use suitable welding face shields. The persons who assist the welders should use suitable goggles. Protective goggles should be worn while chipping and grinding.

(f) Stonebreakers should use protective goggles. They should be seated at sufficiently safe distances from one another.

(g) Safety goggles should be of shatterproof type and with zero power.

(h) Persons engaged in or assisting in shot blasting operations and cleaning the blasting chamber should use suitable gauntlets, overalls, shatterproof and dust-proof goggles and self contained breathing apparatus set.

(i) All persons working at heights more than 3.5 m above ground or floor and exposed to risk of falling down should use full body harness safety belts, unless otherwise protected by cages, guard railings, etc. In places where the use of safety belts is not feasible, suitable net of adequate strength fastened to substantial supports should be used.

(j) When workers are employed in sewers and inside manholes that are in use, it should be ensured that the manholes are opened and are adequately ventilated at least for an hour. After it has been well ventilated, the atmosphere inside the space should be checked for the presence of any toxic gas or oxygen deficiency by a competent person and recorded in the register before the workers are allowed to get into the manholes. A pilot team should enter the area donning self contained breathing apparatus (SCBA). The manholes opened should be cordoned off with suitable railing and provided with warning signals or caution boards to prevent accidents. There should be proper illumination in the night. Depending upon the work situation, the contractor should provide PPE including the SCBA as recommended by Head, industrial safety.

12. MEDICAL MANAGEMENT

12.1 General

(a) The contractor shall make arrangements for the first aid and medical services for the injured or ill persons for prompt attention or aid.

(b) The arrangement can be made by the contractor or an agreement can be in vogue with the facility.

(c) The medical facilities at first-aid centre shall be adequate to immediately cater to the injured based on the hazard potential and probable severe injuries.

(d) The first-aid centre shall be provided with the adequate equipment and medicines for catering to the site requirements. The first-aid centre shall be manned depending on the working hours / on round the clock shift basis. The services of at least one qualified medical practitioner (medical officer) shall be made available by the contractor.

12.2 Medical Facilities

(a) Medical facilities conforming to the provisions of the Atomic Energy (Factories) Rules, 1996 should be provided at all work sites.

(b) The requisite medical facilities in the form of a well-equipped first aid centre manned by qualified nursing personnel should be provided at all work sites. Contractor may avail this facility as per terms and conditions of the contract.

(c) In addition, well-maintained first-aid boxes should be kept at each location of the work by the contractor and availability of the personnel trained in first aid should be ensured.

(d) A manned and equipped ambulance should be available at work site during the working hours/on round-the-clock shift basis.

(e) It should be ensured by the facility that occupational health monitoring of contract workers is carried out as per provisions of the Factories Act 1948 as per the latest amendment and the stipulations/directives given by Atomic Energy Regulatory Board from time to time.

(f) Display of emergency contact numbers of important persons and hospitals and route map of site shall be maintained at designated places.

12.3 Medical Management of Serious Injuries

(a) In case of serious injuries, the injured should be shifted to the nearest first-aid centre at site immediately. The opinion of medical officer/ certifying surgeon should be sought immediately for medical management.

(b) After providing the first aid treatment the injured should be shifted to designated medical facility of the site/hospital for further medical assistance, in an ambulance along with a nursing attendant.

(c) The doctor at the medical facility of the site/hospital attending the case shall assess the extent of injuries and render immediate medical aid. If the situation warrants trauma/special care the injured shall be shifted to the referral hospital, having all the requisite facilities for specialized treatment in ambulance along with a medical attendant.

(d) A list of such referral hospitals for specialised medical management facilities for the injured persons should be available with the project management/Head, industrial safety and Head, medical services of the site for ready reference.

APPENDIX-D

APPLICATION FOR HEIGHT PASS

PART- A

Group/Section: _____

Agency: _____

1. Applicant's name : _____
2. Facility address : _____
3. Residential address : _____
4. Age : _____
5. Sex : _____
6. Height : _____
7. Gate Pass No. : _____
8. Name of contractor/agency with whom engaged at present : _____
9. Height pass required for work at _____ m. Height
10. Description of present job : _____
11. Previous experience of working at height : _____

S.No.	Name of the employer	Duration of employment	Work experience
1.			
2.			

12. Does the applicant suffer from any of the following ailments ? (If yes details to be given):

    (a) Blood pressure _____ (b) Epilepsy _____

    (c) Flat foot _____

    (d) Frequent headache or reeling sensation _____

    (e) Mental depression _____ (f) Limping gait _____

    (g) Aerofobia _____

Declaration:

I hereby declare that the above information furnished by me is true and correct. I shall always wear the safety belt and tie the life-line whenever working at unguarded heights of 3 m and above. I shall not misuse the height pass issued to me or transfer it to any other person. I shall never come to duty or work at height/depth under the influence of alcohol/drugs.

Date: Name:

Sign:

(Applicants Name and Signature or loss time injury (L.T.I) in case he cannot sign. In case of LTI an authorised person shall explain each point/item to the individual and certify on that behalf below the LTI)

I certify that I am satisfied with the above certification of the individual for the application of height pass and request for issue of height pass to him.

Name :

Sign:
(Agency Concerned)

Countersigned by:

Section Head (Facility)

PART-B

MEDICAL FITNESS CERTIFICATE

Certified that I, Dr. _____ have examined Shri._____ _____ aged _____ on (date) _____ who has signed below in my presence. General and physical examinations of Shri._____ do not reveal any abnormality. He does not suffer from any acute/chronic skin disease or any contagious or infectious disease. His eye sight is normal with/without glasses. In my opinion, Shri._____ is physically and mentally fit for working at height.

Details of examinations are given below:

Personal attributes:			**Medical aspects:**		
1.	Height	: _____	1.	Urine	: _____
2.	Chest	: _____	2.	Blood pressure	: _____
3.	Weight	: _____	3.	Epilepsy	: _____
4.	Hearing	: _____	4.	Flat foot	: _____
5.	Sight	: _____	5.	Frequent headache or reeling sensation:	_____
6.	Skin	: _____	6.	Mental depression:	_____
7.	Heart beating:	_____	7.	Limping gait	: _____
			8.	Aerophobia	: _____

Name:

Signature of workman

Signature and Rubber Stamp of Medical Practitioner with Reg. No.

PART-C

INDUSTRIAL SAFETY SECTION

(Considering the above medical certificate, the applicant has appeared on the following practical tests conducted by industrial safety section and the results are given below (strike off whichever is in-applicable)

(a) Wearing a safety belt and tying the rope knot : Pass/fail

(b) Walking over a horizontal structure at 3 m. height wearing a safety belt : Pass/fail

(c) General physique (OK/Not OK)

The above applicant's performance in the above tests has been satisfactory/ unsatisfactory due to the following.

So I certify and issue this height pass to Shri. _____ with Registration No. _____ in the height pass register. This is valid for one year from the date of issue i.e. up to .....

Date:

Name:

Signature

Scientific Assistant (Safety)

Safety Officer

APPENDIX-E

FORM - 1

APPLICATION FOR TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION

[Prescribed under clause 10.6(d)]

1.	Name and address of user.	
2.	Reference of tender or work order (if applicable)	:
3.	Name and designation of tender/work order issuing authority.	:
4.	Power supply application number†	:
5.	Name and designation of tender/work order/work supervising authority (engineer-in-charge).	:
6.	Expected date of commencement of temporary supply	:
7.	Expected date of decommissioning of temporary supply	:
8.	Voltage level (LV/MV/HV)	
9.	Type of connection (1Ph/3Ph)	
10.	Connected load (Kw)	
11.	Maximum demand(KVA)/Power factor	
12.	Single line diagram* of proposed power distribution scheme along with equipment data sheet (downstream installation after point of connection).	Enclosed (Form-1A)/Not enclosed
13.	Name of overall supervisor and available qualified Staff	Enclosed (Form-1B)/Not enclosed
14.	Auxiliary equipment data sheet (meters, fire extinguisher, first aid box etc)	Enclosed (Form-1C/Not enclosed
15.	Name and designation of provider's representative to whom the application is addressed.	:
16.	Name and designation of authorised signatory of user, who had submitted this application	:

† Power supply application number shall be different for same user with multiple applications for temporary supply

* All the drawings and tables shall be signed by user's representative indicated against 16 above.

Signature of authorised signatory of user

Signed endorsement of work order supervising authority indicated against 5 above.

FORM - 1A

EQUIPMENT DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION

(Prescribed against item-12 of form-1)

Name and address of user:

Power supply application Number:

Amendment No:

References:- Single line diagram (SLD) of the power distribution scheme with all equipment details (attach the SLD)

1. Identity	2. Type	3. Make and model	4. Manufacturer's S.No	5. Fixed/ Portable	6. Size	7. Last used date	8. Last test date	9. Latest test data	10. Rating

Signature of authorised signatory of user

Explanation of column headers:

1. Identity:- Identification mark/number/tag of equipment in single line drawing and layout drawing. Every equipment in single line drawing and layout drawing shall have suitable identification mark/number/tag.
2. Type:- Cable/CB/MCB/MCCB/ELCB/transformer/lightning arrestor/earthing station/ earthing connection/motor/lighting fixture/switch/fuse/switch, socket box etc.
3. Make and model:- manufacturer's name and corresponding model no.
4. Manufacturer's S. No:- serial number and date in name plate if available. Else NA
5. Fixed/portable:- Equipment is installed/laid/anchored to surface or portable.
6. Size:- depending upon type of equipment and as desired by provider representative e.g. length for cables or all dimensions if heavy equipment like transformer.
7. Last used date. date of last use else NEW
8. Last test date. latest test date by user or by manufacturer if NEW
9. Latest test data:- IR, HV, resistance, functional test data depending upon the type of equipment as desired by provider's representative.
10. Rating:- name plate rating of equipment like voltage, current, power (apparent, active, reactive), IP of enclosure, size (cable cross section) etc. depending upon the type of equipment and as desired by provider's representative.

FORM - 1B

STAFF DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION
(Prescribed against item-13 of form-1)

Name and address of user:

Power supply application Number:
Amendment No:-

1. Name	2. Address	3. Tel.No.	4. Responsibility	5. Certification detail	6. Resucitation training	7. Expe-rience	8. Other relevant training	9. Signature

Signature of authorised signatory of user

Explanation of column headers:

1. Name:- Name of agency/person
2. Address:-
3. Tel No:- regular, alternate and emergency telephone numbers
4. Responsibility:- whether responsible for installation, operation, maintenance, overall supervision etc. overall supervisor shall be indicated specifically.
5. Certification detail:- (a) type of certification e.g wire man license, electrical supervisor license, electrical contractor license, diploma in electrical engineering, degree in electrical engineering etc. (b) certifying agency e.g. state PWD, central PWD, CEA, name of college/university etc. (c) certificate/license number with date. (d) valid up to date or next renewal date must for contractor/supervisor license.
6. Artificial resuscitation training:- indicate YES/NO if the staff is trained to apply artificial resuscitation technique.
7. Experience.:- number of years of experience.
8. Other relevant training :- any other training in electrical/ safety course. Indicate name of training, duration (days/months), training providing agency.
9. Signature:- original signature of individual.

FORM - 1C

AUXILIARY EQUIPMENT DATA SHEET FOR OBTAINING TEMPORARY POWER SUPPLY AND USE OF ELECTRICITY AT WORK SITE DURING CONSTRUCTION
(Prescribed against item-14 of form-1)

Name and address of user:

Power supply application Number:
Amendment No:-

Reference:- Layout drawing No. / _____

1. Identity	2. Type	3. Make and model	4. Manufacturer's S. No	5. Fixed/ Portable	6. Size	7. Last used date

Signature of user's representative

Explanation of column headers:

1. Identity:- identification mark/number/tag of equipment in layout drawing.
2. Type:- earthing rod/megger/multi meter/earth resistance meter/fire extinguisher/s and bucket/first aid box/resuscitation chart/rubber mat etc.
3. Make and model:- manufacturer's name and corresponding model no.
4. Manufacturer's S. No:- serial number and date in name plate if available. Else NA
5. Fixed/portable:- equipment is installed/laid/anchored to surface or portable.
6. Size:- depending upon type of equipment and as desired by provider representative.
7. Last used date. NEW for new equipment. NA for passive devices like chart/mat etc.

FORM -1D

(Prescribed under clause 4.6(e)]

Name of user agency **Power supply application number:-**

CERTIFICATE BY THE LICENSED ELECTRICAL CONTRACTOR

Certified that subject installations have been carried out by us or checked by us and is in accordance with I.E. Rules. The documents submitted with subject temporary power supply application (Form-1) is verified by us and the complete installation confirms to these documents.

We shall periodically inspect/check the installation so that no unsafe situation arises during use of this temporary power supply system. We understand that for the entire duration of existence of this temporary power supply system we shall be responsible for any unsafe installation, operation, maintenance, testing of the same which results into any loss of life or material. We shall immediately report to the provider's representative and ensure de-energisation of supply if any unsafe situation arises during use of this temporary power supply system.

Signature of the authorised signatory of licensed electrical contractor

Rubber seal of licensed electrical contractor

Date

CERTIFICATE BY THE USER

Certified that my/our installations have been carried out in accordance with the I.E. Rules and that I/We have employed competent agency/staff to handle the installations which is strictly as per the staff data sheet submitted in Form-1B.

We understand that for the entire duration of existence of this temporary power supply system we shall be responsible for any unsafe installation, operation, maintenance, testing of the same which results into any loss of life or material. We shall immediately report to the provider's representative and ensure de-energisation of supply if any unsafe situation arises during use of this temporary power supply system.

Signature of the authorised signatory of user

Name of signatory

Date

FORM -1E

[Prescribed under clause 10.6(f)]

CERTIFICATE BY THE SAFETY OFFICER

Certified that I have inspected the electrical installation referred here in after satisfying myself about the safe condition of the installation, I hereby recommend that the service connection be given to the contractor.

Signature of the safety officer

Name:

Date:

AUTHORISATION BY THE ELECTRICAL ENGINEER

The subject power supply application along with completed installation, necessary certificates (as per Form-1 of Appendix-E) is scrutinised by us. The proposal found to be in order and the installation can be energised on _____ in presence of your designated overall supervisor as indicated in Form-1B. Enclosed herewith the test report data sheet Form-1F. You are requested to carry out the periodic testing of equipment and submit the test report periodically as per this form.

Signature of the electrical engineer
of provider

Name of signatory

Date

FORM - 1F

TEST/MAINTENANCE REPORT DATA SHEET OF EQUIPMENTS OF TEMPORARY POWER SUPPLY SYSTEM AT WORK SITE DURING CONSTRUCTION
(Prescribed against form-1E)

Name and address of user:

Power supply application Number:
Amendment No:-

1. Identity	2. Type	3. Last tested date	4. Next due date of any test	5 Frequency of IR test	6 Frequency of HV test	7. Frequency of earth resistance test	8. Other tests

Signature of electrical engineer of provider

Explanation of column headers:

1. Identity:- Identification mark/number/tag of equipment in single line drawing and layout drawing. Every equipment in single line drawing and layout drawing shall have suitable identification mark/number/tag.
2. Type:- Cable/CB/MCB/MCCB/ELCB/transformer/lightning arrestor/earthing station/ earthing connection/motor/lighting fixture/switch/fuse/switch, socket box etc.
3. Last test date: - latest test date indicated in Form-1A.
4. Next due date of any test:- as worked out by frequency of tests indicated in subsequent columns.
5. Frequency of IR test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
6. Frequency of HV test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
7. Frequency of earth resistance test:- required frequency depending upon type of equipment and location of installation. NA if not required after installation.
8. Other tests:- name and description of any other essential tests/maintenance activity and required frequency depending upon type of equipment and location of installation. NA if not required after installation.

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LIST OF PARTICIPANTS

EXPERT COMMITTEE FOR REVIEW OF 'GUIDELINES' ON CONTROL OF WORKS

Dates of meeting:	July 9, 2007	July 23, 2007
	September 3, 2007	October 3, 2007
	October 17, 2007	February 22, 2008
	April 4, 2008	April 23, 2008
	May 6, 2008	May 13, 2008
	June 18 & 19, 2008	August 4, 2008
	May 12, 2010	

Members of Sub Committee:

Shri P.B. Kulkarni (Chairman)	:	BARC (Former)
Shri Sushil Kumar	:	DGFASLI
Shri D.K. Jain	:	NPCIL
Shri N. Nagaich	:	NPCIL
Shri P. Lahiri	:	BARC
Shri N. Prasad	:	NPCIL
Shri K. Ramprasad	:	AERB
Shri A.K. Tandle	:	BARC
Shri T.V. Sudhikumaran	:	NPCIL
Shri S.R. Bhave (Member Secretary)	:	AERB

Invitees:

Dr. P.K. Sinha	:	NPCIL (Former)
Shri D. Das	:	AERB

Contributors:

Shri R. Bhattacharya	:	AERB
Shri.S. Sounderarajan	:	BARC
Shri.S.R. Bhave	:	AERB
Shri S. Chockalingam	:	AERB

ADVISORY COMMITTEE ON INDUSTRIAL AND FIRE SAFETY (ACIFS)

Dates of meeting	:	July 6, 2009 August 4, 2009 November 30, 2009 February 22, 2010 March 26, 2010 April 29, 2010 July 30, 2010 September 21, 2010

Member ACIFS:

Shri S.K. Mukherjee (Chairman)	:	HPCL, Mumbai (Former)
Shri R.K. Gupta	:	HPCL, Mumbai
Shri M.P. Mahajan	:	HWB (Former)
Shri H.S. Ahluwalia	:	NFC (Former)
Shri S.K. Ghosh	:	BARC
Shri S.E. Kannan	:	AERB (Former)
Shri N.K. Agarwal	:	NPCIL (Former)
Shri P.K. Ghosh	:	AERB (Former)
Shri R. Bhattacharya	:	AERB
Shri K. Ramprasad (Member-Secretary)	:	AERB

PROVISIONAL LIST OF REGULATORY DOCUMENTS ON INDUSTRIAL AND FIRE SAFETY

Reference No.	Title	Year of Publication
AERB/NF/FPS (Rev. 1)	Fire Protection Systems for Nuclear Facilities	2010
AERB/NRF/SG/IS-1 (Rev. 1)	Control of Works	2012
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