

SECTION-C8
PILING

SECTION-C8				
PILING				
CONTENTS				
Clause No.	Description	Page No.		
1.00.00	General Requirement	1		
2.00.00	Pile Installation	2		
3.00.00	Concreting	10		
4.00.00	Reinforcement	11		
5.00.00	Building up of Piles	12		
6.00.00	Breaking off of Piles	13		
7.00.00	100 mm Dia Bore Hole	13		
8.00.00	Low Strain Pile Integrity Test	13		
9.00.00	Load Test on Piles	14		
10.00.00	Sampling, Testing, Acceptance Criteria Including Construction Tolerances	25		
11.00.00	Rates and Measurements	25		
	Annexure-A	29		
	Appendix-I	32		
	Appendix-II	34		
	Appendix-III	35		
	Annexure-I	36		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION	PART-B SECTION-C8 CONTENTS	PAGE 1 OF 1

Clause No.	PILING		
	SECTION-C8		
	PILING		
1.00.00	GENERAL REQUIREMENT		
1.01.00	Content		
	This section covers the technical requirement for installation of bored / driven cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter, including load tests on piles for all types of structures.		
1.01.01	In case of bored piles the initial test piles as well as the working piles shall be installed using the rotary hydraulic rig using air lift technique with bentonite slurry.		
1.01.02	Safe load carrying capacity of pile in vertical compression, horizontal (lateral) and pullout loads for various pile diameters are specified in Annexure-I.		
1.01.03	The Contractor shall ensure and guarantee the "safe load" carrying capacities both for initial test piles and working piles, as mentioned in the Annexure-I.		
1.01.04	Before installing the initial test piles, Contractor shall finalise the pile design including structural design and get the approval from the Engineer. Bidder to note that the minimum length of the pile below Cut-off-level (COL) as specified under "pile Installation/termination Criteria" is also the 'design length' as derived from pile design by the Owner. Bidder should make his own pile design before submitting his bid and in case his estimate of 'design length' for the capacity, diameter and the pile installation/termination criteria as specified in the specification and the Schedule of Items is different from the Owner's estimate, he should clearly declare same in the 'Deviation Schedule' along with supporting design calculations. If the estimated design length as declared by the bidder in the 'Deviation Schedule' is more than the Owner's estimated design length then the extra cost due to the difference in length including the cost of owner issue materials shall be added to his quoted price for the evaluation purposes. However, if his estimated design length for pile is less than the owner's estimated design length, the owners design length shall be considered as minimum pile length binding on the Bidder and no reduction in bid price shall be considered for evaluation purposes. In case there is no Declared deviation by the bidder in respect of design length of pile in		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION	PART-B SECTION-C8
			PAGE 1 OF 36

Clause No.	PILING
1.02.00	<p>the 'Deviation Schedule' in his bid, Owner's estimate of design length of pile for specified capacity shall be binding on the Bidder.</p> <p>Codes and Standards</p> <p>Some of the relevant Indian Standards, codes etc. applicable to this section of specification are enlisted below:</p> <p>IS : 1892 Code of practice for subsurface investigation for foundation</p> <p>IS : 2131 Method of standard penetration test for soils</p> <p>IS : 2911 Code of practice for design and construction of pile foundations</p> <p>(Part 1/Sec.1) Driven cast in situ concrete piles.</p> <p>(Part 1/Sec 2) Bored cast-in-situ concrete piles.</p> <p>(Part-IV) Load test on piles.</p> <p>IS : 6926 Code of practice for diamond core drilling for site investigation for river valley projects.</p>
2.00.00	PILE INSTALLATION
2.01.01	<p>Installation of piles shall be carried out as per pile layout drawings, installation criteria and the instructions of the Engineer. Piles shall be located in the field by providing suitable reference pillars for respective building/structures.</p>
2.01.02	<p>The contractor shall establish the safe load carrying capacity of each type of pile through initial pile load tests in all three modes i.e. vertical, lateral and the pullout. For each test the safe load as derived from the initial load test results should not be less than the safe load carrying capacity in the respective mode as specified in the schedule of items.</p> <p>In case the contractor fails to establish the safe load carrying capacity in the initial load tests (in respective mode), the following shall be applicable:</p> <p>a) Based on the initial load test results, Engineer shall have the right, if he so desires, to derate (i.e. to reduce) the specified safe load carrying capacity of the pile, by not more than 10%.</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	<p>TECHNICAL SPECIFICATION</p> <p>PART-B SECTION-C8</p> <p>PAGE 2 OF 36</p>

Clause No.	PILING
2.01.03	<p>In such a case, for the working as well as the test piles as executed, payment to the contractor for the item of pile installation (i.e. boring or driving as applicable), the item of concreting and reinforcement for pile shall be reduced on prorata basis (i.e. in the ratio of derated pile capacity to specified safe capacity). No recovery shall be made towards the cost of owner issue materials for derating the pile capacity.</p> <p>b) In case the Engineer is unable to exercise the option of derating the pile capacity as above, he shall have full rights to get the work of piling done by any other agency of repute, all at the risk and cost of the Contractor so as to get the work done as per work schedule agreed at the time of award including recovery of the time lost in the process.</p> <p>It is envisaged that the working piles shall be installed after the successful completion of the initial pile load test. In case the contractor desires to install the working piles pending successful completion of initial pile load test, he may be permitted to do so by the Engineer, however he shall have to bear all associated risks & costs involved to make up for the shortfall in the pile capacity, in the event of the failure of the initial pile load tests to establish specified safe load carrying capacity of initial test pile. If the initial pile load tests fail to establish the specified safe load carrying capacity based on the initial load test results, Engineer shall have the right, if he so desires, to derate (i.e. to reduce) the specified safe load carrying capacity of the pile, by not more than 10% and in such case the contractor shall rectify the shortfall in pile capacity of piles already installed by him, by installing additional piles and also constructing the extra (increased) size of the pile cap (due to additional piles). The cost of additional piles and the extra size of pile cap shall be to contractor's account and the reinforcement and cement used for additional piles and the extra size of the pile cap shall be subject to provision of penal recovery at the rate (of procurement rate plus 25 %) specified under relevant clauses of Special Conditions of Contract. Further, for the already installed derated piles, payment to the contractor for the item of pile installation (i.e. boring or driving as applicable) and the item of concreting and reinforcement for pile shall be reduced on prorata basis (i.e. in the ratio of derated pile capacity to specified safe capacity). No recovery shall be made towards the cost of owner issue materials for derating the pile capacity. However, if based on initial pile test results, the safe load carrying capacity of pile is less than 90% of the specified safe load carrying capacity, then all piles installed till such time shall stand rejected. No payment shall be made to the contractor for the rejected</p>
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	<div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 3 OF 36</div>

Clause No.	PILING
2.01.04	<p>piles and reinforcement and cement used for such rejected piles shall be subject to provision of penal recovery at the rate (of two times the procurement rate) specified under relevant clauses of Special Conditions of Contract.</p> <p>If the routine pile load test on any working pile in a pile group fails to establish the specified safe load carrying capacity, the contractor shall rectify the shortfall in pile capacity of piles of the group as decided by the Engineer, by installing additional piles and also constructing the extra (increased) size of the pile cap (due to additional piles). The cost of additional piles and the extra size of pile cap shall be to contractor's account and the reinforcement and cement used for additional piles and the extra size of the pile cap shall be subject to provision of penal recovery at the rate (of procurement rate plus 25%) specified under relevant clauses of Special Conditions of Contract. For the already installed piles of the group, payment to the contractor for the item of pile installation (i.e. boring or driving as applicable) and the item of concreting and reinforcement for pile shall be reduced on prorata basis (i.e. in the ratio of derated pile capacity to specified safe capacity). No recovery shall be made towards the cost of owner issue materials for derating the pile capacity.</p>
2.01.05	<p>The engineer reserves the right to reject any pile which in his opinion is defective on account of poor workmanship, structural integrity, position, alignment, concrete quality or any other reason. Piles which are defective shall be either pulled out by the contractor or left in place as directed 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. Further, the cost of additional piles and increase in the pile cap size, if any, an account of additional piles shall be borne by the Contractor. Reinforcement and cement used for additional piles and the extra size of the pile cap shall be subject to provision of penal recovery at the rate (of two times the procurement rate) specified under relevant clauses of Special Conditions of Contract.</p>
2.01.06	<p>Each pile shall be identified with a reference number. The convenience of installation may be taken into account while scheduling the sequence of piling in a group.</p>
2.01.07	<p>The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown at Annexure-A. On completion of each pile installation, pile record in triplicate shall be submitted to the Engineer within two days of completion of concreting of the pile.</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	<p>TECHNICAL SPECIFICATION</p> <p>PART-B SECTION-C8</p> <p>PAGE 4 OF 36</p>

Clause No.	PILING
2.01.08	Approval of termination depth by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the 'safe load' capacities of the piles as indicated in this document.
2.02.00	Installation/Termination Criteria
2.02.01	Bored Pile The installation/termination level of the pile shall be as per the criteria elaborated in the requirements specified in Annexure-I.
2.02.02	Driven Piles: Not Applicable.
2.02.03	Concreting shall not be done until the above conditions for installation of piles are satisfied.
2.03.00	Control of Position and Alignment
2.03.01	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.
2.04.00	Piling Equipment The equipment and accessories for installation of piles shall be selected giving due consideration to the sub soil conditions, ground water conditions, type of founding material etc. The cutting tool shall be suitable for the strata encountered (or) as approved by the Engineer, if required the contractor shall consult the equipment manufacturer for selection of appropriate cutting tool and shall use/replace the same with no extra cost implications to the owner.
2.05.00	Bored Pile a) Boring / drilling operations shall be done by rotary hydraulic feed drilling rigs with reverse mud circulation / direct mud circulation. The cutting tool shall have suitable ports for the bentonite slurry circulation. The rotary drilling rig shall have suitable and adequate accessories for boring / drilling through all type of strata expected at site. b) Working level shall be above the pile cut-off-level. After the initial boring of about 1m, temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be such as to give the necessary finished diameter of the concrete pile. The center line of guide casing shall be checked
<div> <div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 5 OF 36</div> </div>	

Clause No.	PILING
	<p>before continuing further boring. Guide casing shall be of minimum 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.</p> <p>c) The temporary guide casing (if provided) shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing, concrete shall not be disturbed.</p> <p>d) 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. Dimension/size of cutting tool shall be checked at least once in a month to have a watch on the reduction in size of cutting tool for wear and tear during boring.</p> <p>e) In case hard rock is encountered and chiselling is essentially required for softening of the rock, the same may be adopted only on approval of the Engineer, at no extra cost to the Owner. However, advancement of pile bore shall be done by drilling only.</p> <p>f) Drilling mud (bentonite slurry) shall be used for stabilizing the sides of the pile bore. Drilling mud to be used shall meet the requirements, as given below.</p> <p>i) Liquid limit of bentonite when tested in accordance with IS: 2720 (part v) shall be more than 300 percent and less than 450 percent.</p> <p>ii) Sand content of the bentonite powder shall not be greater than 7 percent.</p> <p>iii) Bentonite solution should be made by mixing it with fresh water using pump for circulation.</p> <p>iv) The marsh viscosity when tested by a marsh cone shall be between 30 to 60 seconds.</p> <p>v) The differential free swell shall be more than 300 percent.</p> <p>vi) The pH value of the bentonite suspension shall be between 9 and 11.5.</p> <p>g) Maintaining the bore hole : The bentonite slurry shall be maintained at least 1.5m above the ground water level during boring operations and till the pile is concreted. The bentonite slurry shall be under constant circulation till start of concreting</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	<p>TECHNICAL SPECIFICATION</p> <p>PART-B SECTION-C8</p> <p>PAGE 6 OF 36</p>

Clause No.	PILING
	<p>and shall meet the requirements stipulated in the subsequent clauses.</p> <p>While withdrawing the cutting tool during the pile boring operation, extra care shall be taken so that no suction is created on the sides or below the cutting tool slowly disturbing the adjoining soil. The cutting tool shall initially be withdrawn in short steps combined with slow rotation so as to allow air and bentonite slurry to flow below the cutting tool, thereby preventing any suction below.</p> <p>h) Cleaning of Pile bore</p> <p>i) After completion of the pile bore up to the required depth, the pile bore shall be cleaned by two stage flushing of slurry using airlift technique i.e after completion of boring and after placement of reinforcement cage but just before commencement of concreting. The bottom of the pile bore shall be thoroughly cleaned by airlift technique. The air pipe shall be as close as possible to bottom of pile bore and shall connect at right angle- (a J-type metal pipe welded / fixed with the bottom segment of tremie pipe) to tremie pipe at bottom from outside the tremie pipe, rather than being lowered straight inside the tremie pipe which will disturb the bottom of boring. The flushing shall be by the jetting action of air in the upward direction through the drilling tool or tremie pipe as the case may be. Cleaning shall ensure that the pile bore is completely free from sludge / bored material, debris of rock / boulder etc. Necessary checks shall be made so as to confirm the thorough cleaning of the pile bore.</p> <p>ii) Pile bore shall be cleaned by fresh drilling mud through tremie pipe before and after placing the reinforcement and just before the start of concreting.</p> <p>iii) Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore possess a density of more than 1.25 t / cu.m. The drilling mud sample shall be collected from the bottom of pile bore. For this 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, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	<p>TECHNICAL SPECIFICATION</p> <p>PART-B SECTION-C8</p> <p>PAGE 7 OF 36</p>

Clause No.	PILING		
	<p>assembly to minimise 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)</p> <p>iv) Consistency of the drilling mud suspension shall be controlled throughout 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.</p> <p>v) A protocol shall be maintained as enclosed at Annexure-A regarding the strata at the pile termination level, SPT value, percent core recovery, Unconfined Compressive Strength (UCS) from the nearest borehole, socketing horizon, time and duration of flushing of pile bore, time interval between end of boring and start of concreting, bentonite density before start of concreting.</p>		
2.06.00	<p>Driven Piles : Not Applicable</p> <p>a) The reinforcement mandrel (casing tube) used for installation of piles shall be straight and shall have sufficient wall thickness and strength to withstand damage, distortion etc. Mandrel distorted from the true and uniform shape resulting in a reduction of more than 10% of its cross sectional area shall not be used. Joints along the length of the casing tube shall be waterproof.</p> <p>(b) The capacity of the pile frame shall be selected after considering the size and weight of the mandrel, the location of work, resistance to driving and shall be adequate so as to achieve the desired penetration.</p> <p>(c) Pile shoe shall be of cast iron, double collar and of requisite strength and shall be of standard size, which can be used with the mandrel chosen for site. However, fabricated double collar mild reinforcement shoe shall also be accepted. The mild reinforcement plates shall conform to IS: 2062.</p> <p>(d) The hammer shall be of sufficient rated energy to obtain the desired penetrations. The drop hammer (diesel or compressed air operated) may be used which shall penetrate the pile shoe to the prescribed depth or desired penetration.</p>		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C6	PAGE 8 OF 36

Clause No.	PILING
	<p>(e) Driving of casing tube shall be done satisfying the installation criteria. Driving shall be done to the required 'set' which shall be assessed by the Contractor so as to ensure safe load capacity of pile indicated in the specification. The 'set' shall depend upon hammer weight, fall of hammer, etc. All relevant data with back up computations pertaining to 'set' shall be submitted by the Contractor to the Engineer for approval before commencing piling work. Care shall be taken not to damage the mandrel and shoe by over driving. To prevent the ingress of water into the casing tube, the joint between the casing tube and pile shoe shall be sealed with bitumen and jute rope (bitumastic). Any sudden change shall be noted and brought to the notice of Engineer. Jetting of casing by means of water shall not be permitted.</p> <p>(f) During driving, the top of pile shall be protected by a suitable helmet of reinforcement construction. The helmet shall provide uniform bearing stress across the pile top and shall hold the pile centrally under the hammer.</p> <p>(g) The stroke of hammer shall be limited to 1.2m unless otherwise permitted by the Engineer.</p> <p>(h) Casing tube shall not be bent or sprung into position but shall be effectively guided and held on line during the initial stages of driving.</p> <p>(i) Inspection of tube - After complete installation of tube, the Contractor shall inform the Engineer who will inspect the tube for proper plumb, location and ingress of water in the casing and other conditions. The existence of water inside casing tube if any, shall be checked by the Contractor by suitable probe. Contractor shall ensure that the water level shall not be more than 150mm above the top of the pile shoe.</p> <p>(j) When working near existing structures, care shall be taken to avoid any damage to such structures.</p> <p>(k) Before placement of concrete, care shall be taken to ensure that the inside of the casing is free from sludge or any foreign matter. The ingress of water into the casing tube shall also be checked and shall meet the stipulations as given above in (i)</p> <p>(l) The concrete shall be so placed as to fill the entire volume of the casing tube without the formation of voids caused by</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	<p>TECHNICAL SPECIFICATION</p> <p>PART-B SECTION-C8</p> <p>PAGE 9 OF 36</p>

Clause No.	PILING
	<p>entrapped air. All precautions for obtaining clean and sound pile shaft shall be followed.</p> <p>(m) Casing tube shall be withdrawn in stages vertically upwards and utmost care shall be exercised in maintaining adequate head of concrete above bottom of the casing at each stage of withdrawal so as to prevent ingress of soil and water into the tube causing contamination of green concrete. However, at any stage of concreting, minimum one metre of height of concrete shall be maintained above the bottom of the casing tube. Care shall be exercised to avoid the squeezing or wasting of the unset concrete in the pile shaft, when the casing is being withdrawn.</p>
2.07.00	Carriage and Disposal
2.07.01	Bored spoil material and contaminated mud shall be disposed off up to a lead of 2 km beyond the plant boundary.
3.00.00	CONCRETING
3.01.00	Technical specification for cast-in-situ concrete and allied works along with IS: 2911 shall be applicable to concrete works for piles.
3.01.01	Minimum grade of concrete shall be M25. Minimum Cement content shall be 400kg / cu.m. or that determined from the mix design, which ever is higher. However, the maximum cement content shall be limited to 450 Kg/cu.m.
3.01.02	The slump of concrete shall vary between 150 to 180 mm and 100 to 180mm for bored and driven piles respectively. Admixtures in concrete are not permitted for piles.
3.02.00	Concreting shall not be done until the Engineer is satisfied that the termination level of pile satisfies the installation criteria mentioned else where in the specification.
3.03.00	The time interval between the completion of boring / driving of casing tube and placing of concrete in pile bore 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 termination level and cleans the pile bore. The entire cost of all operation and Owner Issue Materials for this extra length shall be borne by the Contractor.
<div> <div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-5 SECTION-C8</div> <div>PAGE 10 OF 36</div> </div>	

Clause No.	PILING
3.04.01	Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911. A surge concrete of about 1 to 1.5 cum shall be done in the first pour by suddenly removing the closure plate provided at the bottom of funnel so as to displace completely the sludge/bored material/debris etc. from the bottom of pile bore. Drilling mud shall be maintained sufficiently above the ground water level as specified elsewhere in the specification.
3.04.02	It shall be ensured that volume of concrete poured is not less than the theoretically computed volume of the pile shaft being cast.
3.04.03	Continuous filling of concrete shall be ensured by minimum two numbers of transit mixers. The cold joints in the pile shall be avoided.
3.05.00	Top of Concrete in Pile and Cut-off-Level (COL)
3.05.01	Cut-off-Level of piles shall be as indicated in drawings released for construction and / or as indicated by the Engineer.
3.05.02	The top of concrete in pile as cast shall be above the cut-off-level by 1.0 meter (minimum) to remove all laitance and weak concrete and to ensure good concrete at cut-off-level, for proper embedment into the pile cap.
3.05.03	Cement being used for concreting this extra length of pile above the cut-off-level, as per the requirements of technical specification shall be considered as the material being used for the work, for the purposes of reconciliation of cement consumption, as per the provisions of special conditions of contract.
3.05.04	Preparation of Pile head: The area surrounding the piles shall be excavated upto the bottom of the pile caps. After seven days of concreting of pile, the exposed part of concrete above the COL shall be removed / chipped off and made rough at COL. The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile-cap. The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.
3.05.05	All loose material on the top of pile head after chipping to the desired level shall be removed and disposed off upto a lead of 2Km. beyond the plant boundary or as directed by the Engineer.
4.00.00	REINFORCEMENT
4.01.00	Technical specification for cast-in-situ concrete and allied works along with IS:2911 shall be applicable for reinforcement for piles.
<div> <div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 11 OF 36</div> </div>	

Clause No.	PILING
4.02.00	Longitudinal reinforcement in pile shall be high yield strength deformed reinforcement (HYSD) bars conforming to IS:1786, unless specified otherwise. Lateral reinforcement in pile shall be of mild reinforcement conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.
4.03.00	The longitudinal reinforcement shall project 50 times its diameter above cut-off-level unless otherwise indicated. Any excess length of pile reinforcement may be removed by gas cutting or by any other method approved by Engineer.
4.04.00	The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage. For links, the spacing shall not be less than 150mm and in no case more than 250mm.
4.05.00	Proper cover to reinforcement and central placement of the reinforcement cage in the pile bore shall be ensured by use of minimum three circular cover blocks, cast specifically for the purpose. Concrete cover blocks shall be provided at a spacing not more than 2m c/c at the bottom ring and also be provided at the junction of the two segments of reinforcement cage. While lowering the reinforcement cage two hooks shall always be used to prevent tilting. Placement of reinforcement cage to its full length shall be ensured before concreting. The cage shall be suspended by means of 2 nos. of 12 dia. hanger bar supported from casing pipe. The hanger bar shall be only considered for material reconciliation as scrap and will not be measured for payment.
4.06.0	Minimum clear cover to the reinforcement shall be 50 mm, unless otherwise mentioned.
4.07.0	While lowering the reinforcement cage in two or more segments, lapping reinforcements shall be welded for suitable length to transfer the weight of lower segment to upper segment and also to arrest distortion of reinforcement cage. Helical links as well as inner rings shall also preferably be welded at the lapping portion, to ensure smooth lowering of reinforcement cage.
5.00.00	BUILDING UP OF PILES
5.01.00	If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut-off-level, then the pile shall be built up by using at least one grade higher concrete than specified for piles, ensuring proper continuity with the existing concrete by adopting the measures specified for the construction joint between old concrete with
<div> <div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 12 OF 36</div> </div>	

Clause No.	PILING
	fresh concrete in the cage -in situ concrete and allied works 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.
6.00.00	BREAKING OFF OF PILES
6.01.00	If any pile already cast requires breaking, due to subsequent change of cut-off-level, 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.
7.00.00	100 mm DIA BORE HOLE
7.01.00	The equipment for boring shall be Hydraulic rig with Rotary mud circulation unit. Bore hole shall be made as per IS: 1892 for determining which is one of the criteria of establishing start of socketing horizon and termination level of piles. Standard Penetration Test (SPT), as per IS: 2131, in a bore hole shall be conducted at 3.0 m interval in the overburden soil and rock portion having core recovery < 30%. The borehole shall terminate at least 5m below the pile termination level.
7.02.00	Coring in rock shall be done and cores of Nx size shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth of 5 m into rock with RQD (Rock Quality Designation) $\geq 50\%$, or 5 m below pile termination level, whichever is earlier or as directed by the Engineer. Coring in rock shall conform to IS: 6926. Uniaxial compressive strength test shall also be performed on rock cores. 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.
7.03.00	Number of bore holes for determining termination shall vary depending on the site condition and as decided by the Engineer. In case of uniform strata, one borehole may be sufficient for 50-70 piles or in a pile group. In case of varying strata, the number of boreholes may be 1 in 30 to 40 piles. However, for initial load test piles, one such borehole shall be done near to each test pile group location.
8.00.00	LOW STRAIN PILE INTEGRITY TEST
8.01.00	Low strain integrity test shall be conducted on all the working piles, on all test piles and as directed by the Engineer. The system shall have
<div>BARH STPP (3 X 660 MW) 400/132KV SWITCHYARD PACKAGE</div>	
<div>TECHNICAL SPECIFICATION</div>	
<div>PART-B SECTION-C8</div>	
<div>PAGE 13 OF 36</div>	

Clause No.	PILING
	the computer readout facility and report on the findings of this shall be furnished to the Engineer. This test shall also be used to identify the piles for carrying out routine load test. The test equipment shall be of TNO or PDI make or equivalent. The process shall conform to ASTM.
8.02.00	Piles shall be trimmed to cut-off-level or sound concrete level, whichever occurs later and as directed by the Engineer. No pile cap work shall be undertaken prior to this test. The test shall be carried out after 21 days from the date of concreting for cast in situ piles. However, the Engineer may permit the test after 14 days in exceptional cases.
8.03.00	The test shall be undertaken through an independent specialist agency approved by Engineer. This test is limited to assess the integrity of the shaft such as imperfections or discontinuities and is not intended to replace the use of static load testing.
8.04.00	Methodology
8.04.01	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.
8.04.02	A small metal / hard rubber hammer is used to produce a light firm 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.
8.04.03	Based on the integrity test a report shall be submitted to the Engineer indicating the integrity of pile, pile length, velocity of wave through concrete etc within a week to the Owner. Further the contractor should submit the suggested list of piles for carrying out routine load tests. Then the contractor should finalise in agreement with owner, the piles for carrying out routine load tests.
9.00.00	LOAD TEST ON PILES
9.01.00	This part of the specification covers the requirements for initial and routine load tests on reinforced concrete single vertical piles of specified diameter to assess their vertical, horizontal (lateral) and pull out load carrying capacities.
9.02.00	The work shall include mobilisation of all necessary equipment, kentledge, anchor piles / rock anchors, or combination of kentledge and anchor piles / rock anchors, all associated enabling works, providing
BARH STPP (3 X 660 MW) 400/132KV SWITCHYARD PACKAGE	
TECHNICAL SPECIFICATION	
PART-8 SECTION-C8	
PAGE 14 OF 36	

Clause No.	PILING
	necessary engineering, supervision and technical personnel, skilled and unskilled labour, etc., as required, to carryout the complete pile testing and submission of test reports.
9.03.00	The Contractor shall carryout all works meant within this specification for successfully carrying out the pile load tests, even if not explicitly mentioned under the scope. All works shall be carried out to the satisfaction of the Engineer.
9.04.00	All pile testing shall conform to IS: 2911(Part IV) and modified to the extent given below.
9.05.00	It is essential that all equipments and instruments are properly calibrated both at the commencement and immediately after the completion of tests, so that they represent true values. If the Engineer so desires, the Contractor shall arrange for having the instruments calibrated in presence of the Engineer, at an approved laboratory at his cost and the test report / calibration certificate shall be submitted to the Engineer.
9.06.00	The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as a unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer.
9.07.00	The reaction load to be made available for the test shall be atleast 25% greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.
9.08.00	The load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack with a least count of not more than 10% of the safe load.
9.09.00	The displacement of pile (in vertical, horizontal and uplift) shall be measured using LVDT's having a least count of 0.01mm.
9.10.00	Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	
TECHNICAL SPECIFICATION	
PART-B SECTION-C8	
PAGE 15 OF 36	

Clause No.	PILING	
9.11.00	Full details of the equipment proposed to be used, the test setup and pile testing scheme along with detailed design, drawings shall be submitted to the Engineer, before making arrangements to carryout the tests, for his approval. Approval of the Engineer shall also be obtained after the test set up is complete prior to commencement of loading.	
9.12.00	All operations in connection with pile load test shall be carried out in a safe manner to ensure the safety of man and material.	
9.13.00	<p>a) Proforma for pile load tests shown at Appendix-I shall be submitted in triplicate to the Engineer immediately on completion of each test. The record shall also include the plots of (i) load vs settlement and (ii) time vs settlement (for each increment of Load), (iii) characteristics of the piles and interpretation of the pile load test curve as per the criteria for safe loads, as mentioned in the specification. The copy of details of the test pile from pile log book shall also be included in the report of the pile load test.</p> <p>b) Two fixed independent benchmarks shall be established as reference point at least 15m from the test pile to monitor the settlements.</p>	
9.14.00	If any initial pile load test gets abandoned and / or is not successfully completed then the Contractor shall install another test pile and repeat the initial test after correcting the fault, at his own cost. Cement and reinforcement consumed on account of repeat of initial load test shall be subject to provision of penal recovery at the rate (of procurement rate plus 25%) specified under relevant clauses of Special Conditions of Contract.	
9.15.00	Test Pile Installation	
9.15.01	Piles shall be installed as specified elsewhere in this specification.	
9.15.02	Pile installation data as applicable shall be furnished along with the load test results in triplicate, to the Engineer.	
9.16.00	Type of Pile Load Tests	
9.16.01	The Contractor shall carry out two categories of load tests i.e. initial load test and routine load test.	
9.16.02	Initial load test shall be conducted to assess the safe load carrying capacity of pile before start of installation of working Piles. This shall include the following type of tests.	
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION PART-B SECTION-C8 PAGE 16 OF 36

Clause No.	PILING
9.16.03	<p>a) Cyclic vertical (compression) load test to assess safe vertical load capacity.</p> <p>b) Lateral load test to assess safe horizontal load capacity.</p> <p>c) Pullout (tension) load test to assess safe pull out load capacity.</p> <p>Routine load tests shall be conducted to verify the load carrying capacity of working pile. This shall include the following types of tests:</p> <p>a) High Strain Dynamic Pile load test for vertical load capacity.</p> <p>b) Direct vertical (compression) load test for vertical load capacity</p> <p>c) Lateral load test for horizontal load capacity.</p>
9.16.04	The minimum number of routine load test on working piles shall be as given in BOQ and as directed by Engineer. The results of direct routine load vertical load test shall also be used for correlation with the results of High Strain Dynamic Testing.
9.17.00	Test Pile
9.17.01	The test piles for routine load test shall be identified by the Engineer. For initial load test, test piles shall be installed at locations as directed by the Engineer.
9.17.02	A minimum time period of four weeks shall be allowed between the time of pile casting and testing. Test pile head shall be prepared for testing purposes minimum one week after casting the pile.
9.17.03	Test piles shall be cut off at the proper level and provided with a proper cap / head, so as to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and LVDT's.
9.18.00	Vertical Load Test
9.18.01	<p>Equipment and Test Set up</p> <p>A steel plate of sufficient thickness but not less than 50mm shall be centered on the pile head / cap to prevent pile head it from crushing under applied load. The size of the circular test plate shall not be less than the pile size nor less than the area covered by the base of the hydraulic jack (s).</p>
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	
TECHNICAL SPECIFICATION	
PART-B SECTION-C8	
PAGE 17 OF 36	

Clause No.	PILING		
9.18.02	<p>The datum bars shall be supported on immovable supports preferably of concrete pillars or steel sections placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of test pile and in no case less than 2 metres from the edge of test pile. These supports shall be placed at a sufficient depth below ground to be unaffected by ground movements.</p> <p>Loading System</p> <p>The test load on pile shall be applied in one of the following ways as approved by the Engineer.</p> <p>i) For pile dia upto 500 mm</p> <p>By means of hydraulic jack(s), which obtain reaction from kentledge or anchor piles/rock anchors or combination of anchor piles/rock anchors and kentledge. While using this method, care shall be taken to ensure that the center of gravity of kentledge is on the axis of the pile. The load applied by the jack(s) shall also be coaxial with the pile. The nearest edge of the crib supporting the kentledge stack shall not be closer than 1.5 metres to the edge of the test pile.</p> <p>ii) For pile dia more than 500 mm</p> <p>By means of hydraulic jack(s), which obtain reaction from anchor piles/rock anchors alone or combination of anchor piles/rock anchors and kentledge. The anchor piles shall be at a centre to centre distance of at least three times the test pile shaft diameter from the test pile and in no case less than 2 metres. Reaction or Anchor piles shall be terminated atleast 2.0 m below the termination level of test piles. Reaction from kentledge alone for initial test piles is not permitted.</p> <p>iii) The measurement of strains for load monitoring may also be done by load cell connected to a digital read out unit.</p>		
9.18.03	<p>Measuring System</p> <p>(i) Settlement / movement of the pile top shall be made by four Linear Variable Differential Transducers (LVDTs) having at least 50mm of travel. The read out unit shall have a minimum display of 3½ digits, capable of monitoring output at least 10 DC/PC type LVDTs.</p>		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION <table border="1"> <tr> <td>PART-B SECTION-C8</td> <td>PAGE 18 OF 36</td> </tr> </table>	PART-B SECTION-C8	PAGE 18 OF 36
PART-B SECTION-C8	PAGE 18 OF 36		

Clause No.	PILING		
9.18.04	<p>(ii) Additionally a graduated scale of at least 150mm long and divided in graduations of 0.5 mm shall be fixed to the pile and tungsten wire shall be fixed in opposite side. Measurement of the pile settlement shall also be done by a suitable total station / digital theodolite. Arrangement of setup for measuring system is shown in Appendix II. Typical set up for measuring system shall be submitted by the Contractor to the Engineer in advance.</p>		
	<p>Test Procedure</p> <p>The test shall be carried out by the cyclic loading method for initial load test and by the direct loading method in successive increments for routine load test.</p>		
	<p>A) Direct Loading Method</p> <p>The test shall be carried out as per the procedure outlined below:-</p> <p>a) The load shall be applied to the pile top in increments (steps) of about 20% of the rated capacity of the pile or as directed by Engineer. Each increment of load shall be applied as smoothly and expeditiously as possible. Settlement reading shall be taken before and immediately after the application of next increment and at 15, 30 minutes and thereafter at every 1/2 hour until application of the next load increment.</p> <p>b) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2mm / hr or until two hours have elapsed, whichever is earlier.</p> <p>c) The rate of movement of pile shall not be permitted to be extrapolated from period of test less than one hour.</p> <p>d) Loading on the pile shall be continued till one of the following takes place:</p> <p>i) In case of initial load test</p> <ul style="list-style-type: none">- Applied load reaches three times the safe vertical load carrying capacity.- The maximum settlement of pile exceeds a value of 10 percent of pile diameter.		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 19 OF 36

Clause No.	PILING		
	<p>ii) Incase of Routine Load Test</p> <ul style="list-style-type: none">- Applied load reaches one and half times the safe vertical load carrying capacity.- The maximum settlement of Test Loading in position attains 12mm. <p>e) Where yielding of the soil / rock does not occur, full test load shall be maintained on the pile head for a minimum period of 24 hrs. after the last increment of load has been applied. Settlement /values shall be recorded at every 6 hrs interval during this period.</p> <p>f) Unloading shall be carried out in the same steps as loading. A minimum period of 30 minutes shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.</p> <p>B) Cyclic Loading Test</p> <p>The test shall be carried out to find out separately skin friction and point bearing capacity of single pile. The test procedure shall be as given below.</p> <p>a) In general, this test shall be conducted on similar lines as mentioned in direct loading method. In addition, alternate loading and unloading upto zero load shall be done in steps at each stage of loading. The load increment / decrement for each step shall be 20% of the rated capacity. The readings of all the LVDTs shall be recorded at the end of each step and the total and net settlement for each stage shall be calculated.</p> <p>b) For each stage, the loading of each step shall be maintained for 15 minutes before reaching the maximum load. The maximum load for each stage shall be maintained for one hour. The full test load shall be maintained on the pile head for 24 hrs. (for details refer Appendix - III)</p> <p>c) Each step of unloading shall be maintained for 15 minutes and the subsequent rebound in the pile shall be measured accurately.</p>		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 20 OF 38

Clause No.	PILING				
	<p>d) A period of 15 minutes shall be allowed to pass between the successive unloading and loading operations.</p> <p>e) To find out separately skin friction and point bearing capacity of pile, the procedure as given in Appendix A of IS : 2911 part IV shall be followed.</p>				
9.18.05	<p>Assessment of Safe Load</p> <p>The safe vertical load carrying capacity of single pile from the initial vertical load tests shall be the least of the following values :</p> <p>i) Two-third of the final load, at which the total settlement is 12mm.</p> <p>ii) 50 percent of the final load, at which the total settlement equals to 10 percent of the pile diameter.</p>				
9.18.06	<p>A routine load test is considered to be successful if the total settlement of 1.5 times the safe load does not exceed 12mm.</p>				
9.19.00	<p>Horizontal (Lateral) Load Test</p>				
9.19.01	<p>Equipment and Test set up</p> <p>a) The test plate shall be set in high strength grout to provide full bearing against the projected areas of the pile. The size of the circular test plate shall be adequate to accommodate the spherical bearing and transfer the load to the pile.</p> <p>b) Sufficient clearance shall be allowed between the test pile and the datum bar for the anticipated lateral movement of the pile, when datum bar (for fixing the LVDT) is located on the opposite side to the point of load application.</p>				
9.19.02	<p>Loading System</p> <p>a) Loading shall be applied by a hydraulic jack of adequate capacity equipped with spherical bearing at the top of ram and bearing plate at the bottom side, abutting the pile horizontally and reacting against a suitable system.</p> <p>b) The reaction may be provided by the wall of the excavated pit, when the test is being conducted below ground level or by a neighboring pile, in which case thrust pieces shall be inserted</p>				
<table><tr><td>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</td><td>TECHNICAL SPECIFICATION</td><td>PART-B SECTION-C8</td><td>PAGE 21 OF 36</td></tr></table>		BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 21 OF 36
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 21 OF 36		

Clause No.	PILING
	<p>on either end of the jack to make up the gap, as approved by the Engineer.</p> <p>c) Load shall be applied on the pile preferably at Cut-Off-Level (COL).</p>
9.19.03	<p>Measuring System</p> <p>a) The deflection shall be measured at a point diametrically opposite to the point of Load application. Use of LVDTs placed on opposite side of the load application as mentioned elsewhere shall be done to measure deflection.</p> <p>b) Deflection of the pile at the level of load application shall be measured. The datum bar shall rest on immovable supports, as described elsewhere in this specification.</p>
9.19.04	<p>Test Procedure</p> <p>a) The test procedure shall be similar to that for vertical load test.</p> <p>b) Loading on the pile shall be continued till one of the following takes place:</p> <p>i) In case of Initial load test</p> <ul style="list-style-type: none">- Applied load reaches three times the safe lateral load carrying capacity.- Deflection of pile at the loading point exceeds 12 mm. <p>ii) In case of routine load test</p> <ul style="list-style-type: none">- Applied load reaches one and half times the safe lateral load carrying capacity.- Deflection of pile at the loading point exceeds 5 mm.
9.19.05	<p>Assessment of Safe Load</p> <p>The safe lateral load carrying capacity of single pile from the initial lateral load test shall be the least of following values:</p> <p>i) 50 percent of the final load, at which the total deflection is 12mm.</p>
<div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 22 OF 36</div>	

Clause No.	PILING
	<p>ii) Load corresponding to 5 mm total deflection.</p> <p>Note : Deflection of the pile measured is at the Cut-Off-Level of the pile.</p>
9.19.06	A routine load test is considered to be successful if the total settlement at 1.5 times the safe load does not exceed 5 mm.
9.20.00	Pull Out Load Test
9.20.01	Equipment and Test set up <p>Uplift force may be applied by means of hydraulic jack(s) and / or load cell as mentioned elsewhere using a suitable pullout set up, as approved by the Engineer.</p>
9.20.02	Loading System <p>a) Load shall be applied along the longitudinal axis of the pile using an approved reaction system. Uplift forces on the pile may be applied directly to the test pile or through a lever system.</p> <p>b) The reaction may be provided by neighboring piles or blocks constructed for this purpose.</p> <p>c) The distance between the test piles and the reaction supports / blocks / piles shall be at least 2.5 times the test pile diameter.</p>
9.20.03	Measuring System <p>a) Displacement of the pile shall be recorded using LVDTs as mentioned elsewhere in this specification.</p>
9.20.04	Test procedure <p>a) The test procedure shall be similar to that for vertical load test.</p> <p>b) Loading on the pile shall be continued till one of the following takes place:</p> <p>i) In case of Initial load test</p> <p>- Applied load reaches three times the pullout load carrying capacity.</p>
<div> <div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 23 OF 36</div> </div>	

Clause No.	PILING
	<p>- The load - displacement curve shows a clear break (downward trend)</p>
9.20.05	<p>Assessment of Safe Load</p> <p>The safe pullout Load carrying capacity of single Pile from the Initial Load Test shall be the least of following values:</p> <p>i) Two-third of the final load, at which the total displacement is 12 mm.</p> <p>ii) 50 percent of the load, at which the load displacement curve shows a clear break (downward trend).</p>
9.21.00	<p>High Strain Dynamic Load Testing</p> <p>High Strain Dynamic Load Testing shall be carried for routine load testing of working piles. The procedure to carryout the test shall be submitted to the Engineer.</p>
9.21.01	<p>High Strain Dynamic Pile Testing on piles shall be conducted using Pile driving analyzer. The equipment shall have ability to record both force and velocity. Both strain and acceleration sensors shall be used to collect data and atleast two pairs shall be connected at diametrically opposite sides of the pile near the pile head. An impact hammer or heavy guided block is dropped on to the pile head. The generated compression wave travels from the pile and reflect from the pile toe upward. The waves are picked up by the sensors, processed and stored in the field by the computer. The test and equipment shall conform to ASTM D4945-89. The test shall be conducted by an experienced independent test agency approved by the owner.</p>
9.21.02	<p>Equipment and Site Arrangement</p> <p>High strain dynamic testing shall be performed using pile driving analyzer of make PDI or TNO or equivalent with its allied strain and acceleration sensors, cables etc. The pile shall be tested minimum 21 days after installation. However, the Engineer may permit the test after 14 days in exceptional cases.</p> <p>The hammer weight and setup arrangements shall be as per specifications of testing agency, however the following guidelines can be used. The test shall be conducted by impacting the pile top with a hammer whose weight is 1 % to 1.5 % of the test load. The drop height shall normally vary from 1m to 3m. A single line crane or winch and tripod shall be used for the impact.</p>
<div>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</div>	
<div>TECHNICAL SPECIFICATION</div>	
<div>PART-B SECTION-C8</div>	
<div>PAGE 24 OF 36</div>	

Clause No.	PILING
	<p>The pile head for the test shall be rebuilt to minimum 1.6 times pile diameter using formwork or casing. If casing is used, windows 200mm x 200 mm shall be cut into the pile casing at 1.5 diameters above COL for fixing sensors. Plywood cushion and reinforcement plate shall be placed onto the pile head before impact and this shall be based on test agency recommendations although minimum 20mm thickness shall be used.</p>
9.21.03	<p>Test Results</p> <p>The report shall be submitted within 1 week of testing and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.</p>
9.21.04	<p>Interpretation and Comparison with static load test</p> <p>The contractor shall have to conduct the High Strain Dynamic Tests on selected working piles based on the results of low strain pile integrity test as given in the schedule of items. Engineer will select one or more number of piles from the above working piles in which High Strain Dynamic Testing is already carried out to carry out static routine vertical load test for establishing the correlation between two tests.</p> <p>In case of discrepancy if any between dynamic and direct vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail.</p>
10.00.00	<p>SAMPLING, TESTING, ACCEPTANCE CRITERIA INCLUDING CONSTRUCTION TOLERANCES</p>
10.00.01	<p>Frequency of sampling, testing and quality assurance including the method of conducting the tests, acceptance criteria and construction tolerances shall be as given in Part-C of this specification.</p>
11.00.00	<p>RATES AND MEASUREMENTS</p>
11.01.00	<p>Rates</p>
11.01.01	<p>This clause shall be read in conjunction with the clause for the unit rate given in Part-A of this specification.</p>
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	
<p>TECHNICAL SPECIFICATION</p>	
<p>PART-B SECTION-C8</p>	
<p>PAGE 25 OF 36</p>	

Clause No.	PILING
11.01.02	Unit rate for low strain pile integrity test shall also include for mobilization of the entire set of equipment, computer readout, printer and any other equipment which may not have been included in the description but are essential for satisfactory completion of the work, as per internationally accepted practices. The rates shall be inclusive of repeatability of test, preparation of pile top surface etc and submission of reports along with recommendation / interpretation of results.
11.01.03	Unit rate for High Strain Dynamic Test shall also include for mobilization of the entire set of equipment, hammer weight, sensors, plywood cushions, reinforcement plate, computer readout, printer and equipment which may not have been included in the description but are essential for satisfactory completion of the work, as per internationally accepted practices. The rates shall be inclusive of repeatability of test, preparation of pile of required length, top surface etc and submission of reports along with recommendation / interpretation of results. However the quoted rate of the bidder must include the pile built up of minimum 1.6 x pile diameter done over the pile COL to carryout the test, including the cost of cement and reinforcement.
11.01.04	<p>Unit rates for Initial pile load test shall also include for:</p> <p>a) Preparing the scheme including associated design for pile testing and getting the same approved from the Engineer, including the submission of test report.</p> <p>b) Preparation of pile head to perform initial load test,</p> <p>c) Keeping the test pit dry including de-watering, making the annular space casing, if required.</p> <p>d) All excavation and back filling of the test pit required for initial load test.</p> <p>e) All kentledge, suitable loading frame, anchor piles, rock anchors, or combination of any of these including associated enabling works, cement, reinforcement in anchor/reaction piles, concrete blocks, whatsoever required.</p>
11.01.05	<p>Unit rates for routine pile load test shall also include for:</p> <p>a) Preparing the scheme for pile testing and getting the same approved, from the Engineer, including submission of test report.</p> <p>b) Keeping the test pit dry including de-watering, if required.</p>
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	
TECHNICAL SPECIFICATION	
PART-B SECTION-C8	
PAGE 26 OF 36	

Clause No.	PILING
	<p>c) All additional excavation and back filling of test pit, over and above the pile cap size, required for routine load test.</p> <p>d) All kentledge, suitable loading frame, anchor piles, rock anchors, or combination of any of these including cement, reinforcement in anchor/reaction piles, concrete blocks, whatsoever required.</p>
11.01.06	Unit rate for concreting in pile shall also include for specified extra length of the pile above Cut-Off-Level. However the cement for reconciliation shall be considered for maximum length of 1 m above COL.
11.02.00	<p>Measurements</p> <p>This clause shall be read in conjunction with the clause for the measurements given in Chapter-A of this specification.</p>
11.02.01	The item of pile installation by boring through soil including weathered rock shall be measured in linear measurement for the length bored from ground level through soil / weathered rock up to approved start of socketing level of the pile or termination level of piles in metres for piles in soil.
11.02.02	The item of pile installation by drilling through rock below socketing level / horizon shall be measured in linear measurement for the actual length in meters. However, rock drilling above socketing horizon shall be measured as boring through soil, including weathered rock.
11.02.03	The item of concreting in pile shall be measured in linear measurement for the length of pile below the cut-off-level in meters.
11.02.04	Reinforcement in pile shall be measured in tonnes in the item of reinforcement as stipulated in cast in situ concrete and allied works. The hanger bars for hanging the cage shall be measured for material reconciliation as scrap and will not considered for payment as directed by the Engineer.
11.02.05	Concrete, reinforcement, formwork required for building up of piles shall be measured under the respective items of concrete reinforcement, formwork, as applicable. However for the High Strain Dynamic Load Test the top built up of 1.5 m done over the pile COL to carryout the test will not be measured for the payment.
11.02.06	The item of breaking off of piles, due to subsequent change in design cut-off-level shall be measured in cubic metres.
<p>BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE</p>	
<p>TECHNICAL SPECIFICATION</p>	
<p>PART-B SECTION-C8</p>	
<p>PAGE 27 OF 36</p>	

Clause No.	PILING	BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 28 OF 36
11.02.07	The item of making 100mm nominal borehole and coring in rock shall be measured in linear measurement in metres.					
11.02.08	The item of low strain pile integrity test shall be measured in number of piles tested.					
11.02.09	The item of high strain dynamic test shall be measured in number of piles tested. However, any tests abandoned or not completed shall not be paid.					
11.02.10	The item of initial vertical, lateral and pullout load tests shall be measured in numbers of initial load tests. However, any tests abandoned or not completed shall not be paid.					
11.02.10	The item of routine vertical and lateral load tests shall be measured in numbers of routine load tests. However, any test abandoned or not completed shall not be paid.					

Clause No.	PILING
	<p style="text-align: right;">ANNEXURE-A</p> <p>PILE DATA</p> <ol style="list-style-type: none"> 1. Reference No. Location (Co-ordinates)_____ area. 2. <ol style="list-style-type: none"> a) Type/Name of piling rig b) Size of cutting tool used (bucket/auger). 3. Sequence of piling 4. Pile diameter & type 5. Working level (Platform level/Existing GL) 6. Cut off level (COL) 7. Actual length below COL 8. Pile termination level <ol style="list-style-type: none"> (a) Start of socket Level for rocky strata: (b) Termination of pile (Level): 9. Top of finished concrete level 10. Date and time of start and completion of boring. 11. Depth of ground water table in the vicinity. 12. Type of soil / rock at pile tip 13. Method of boring operation 14. Details of drilling mud as used: <ol style="list-style-type: none"> i) Freshly supplied mud <div style="margin-left: 20px;"> liquid limit sand content density marsh viscosity swelling index pH value </div>
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	<div style="display: flex; justify-content: space-between;"> <div>TECHNICAL SPECIFICATION</div> <div>PART-B SECTION-C8</div> <div>PAGE 29 OF 36</div> </div>

Clause No.	PILING			
	ii) Contaminated mud. density sand content			
15.1	Standard Penetration Test (SPT) Penetration for 100 blows at Socketing Level for reference pile:			
15.2	Unconfined Compression Strength (UCS) Value in rock (from the nearest bore hole): Core recovery (from the nearest bore hole):			
15.3	Rate of drilling in mm / hr.:			
	a) In soils upto socketing horizon			
	b) Below socketing horizon upto termination level			
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 Inner ring	Hangers
	No. _____	No. _____	No. —	No.
	Dia _____	Dia _____	Dia.	Dia.
	Depth _____	Spacing _____	Spacing	Length
	No. of Laps	No. of Laps		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION		PART-B SECTION-C8
				PAGE 30 OF 36

Clause No.	PILING
	<p>23. Any other information regarding obstructions, delay and other interruption to the sequence of work like compressor failure, rig failure, crane failure, transit mixture failure etc.</p> <p>24. Pile bore log details (in brief).</p> <p>25. A suggested pile register is enclosed at Appendix-III.</p>
BARH STPP (3 X 660 MW) 400/132KV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION PART-B SECTION-C8 PAGE 31 OF 36

Clause No.	PILING		
	<div style="text-align: right;">APPENDIX - I</div> <div style="text-align: center;">PROJECT _____</div> <div style="text-align: center;">PILE LOAD TEST: VERTICAL / HORIZONTAL / UPLIFT</div> <div style="text-align: center;"> Pile No. : Date of cast : Method of boring : Type/Name of hydraulic rig: Type & size of cutting tool: Type of pile : Diameter : Capacity : Type of test : Loading method : Direct / Cyclic details : Commencement of test : Completion of test : Brief description of testing arrangement : Tension or Compression piles : Capacity of jack : Jack constant : Weight of kentledge (Routine load test) Reaction pile load + Weight of kentledge (if any) ----- (Initial load test) </div>		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION	PART-B SECTION-C8
			PAGE 32 OF 36

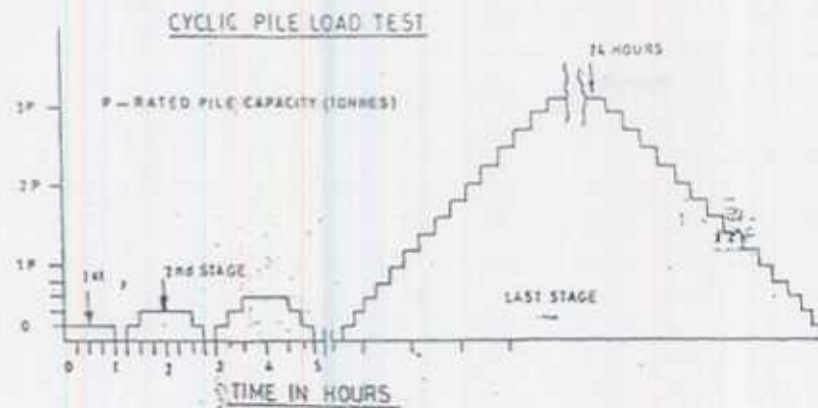
Clause No.	PILING				
	<div>-----</div> <div>DATE TIME PRESSURE LOAD DIAL GUAGE SETTLEMENT(mm)</div> <div>REBOUND GAUGE MT READING -----</div> <div>AVERAGE NET</div> <div>-----</div>				
	<p>Submission of test results:</p> <p>i) Time vs Settlement.</p> <p>ii) Load vs. Settlement indicating the safe load.</p> <p>iii) Separation of skin friction & end bearing of pile, in case of cyclic initial vertical load tests.</p>				
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION		PART-B SECTION-C8	PAGE 33 OF 36

Clause No.	PILING		
	<div style="text-align: right;">APPENDIX - II</div> <div style="text-align: center;">TYPICAL SETUP FOR MEASURING SYSTEM</div> <div style="text-align: center;">PLAN</div> <div> </div> <div style="text-align: center;">SECTION</div> <div> </div> <div style="text-align: center;">DETAIL A FOR LVDTs</div> <div> </div>		
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE	TECHNICAL SPECIFICATION	PART-B SECTION-C8	PAGE 34 OF 36

Clause No.

PILING

APPENDIX - III



NOTE:- LOADING AND UNLOADING TIME IS NOT INCLUDED IN THIS CHART

Clause No.	PILING			
	ANNEXURE - I			
	Pile Capacity (Clause 1.01.02)			
	Safe load carrying capacity of different diameters and in various modes for the minimum length specified are as follows:			
	Pile dia.	Safe vertical capacity (t) (Compression)	Safe Lateral capacity (t) (Horizontal)	Safe uplift capacity (t) (Tension)
	600 mm	140	7	28
	760 mm	225	12.5	50
	Pile Installation / termination criteria (Clause 2.02.01)			
	The termination level of the pile shall be decided based on the following criteria :			
	I. Minimum length of the pile below COL shall be as follows :			
	For 600 mm dia pile	-	29m.	
	For 760 mm dia pile	-	34m.	
	II. In each pile group, one reference pile shall be identified in consultation with the Engineer for conducting SPT (Standard Penetration Test) in the pile bore. The SPT N value at pile termination level shall not be less than 40 for 600 mm dia pile and 45 for 760 mm dia pile. However, based on the available details, the Engineer may reduce the frequency of reference piles.			
BARH STPP (3 X 660 MW) 400/132kV SWITCHYARD PACKAGE		TECHNICAL SPECIFICATION		PART-B SECTION-C8
				PAGE 36 OF 36